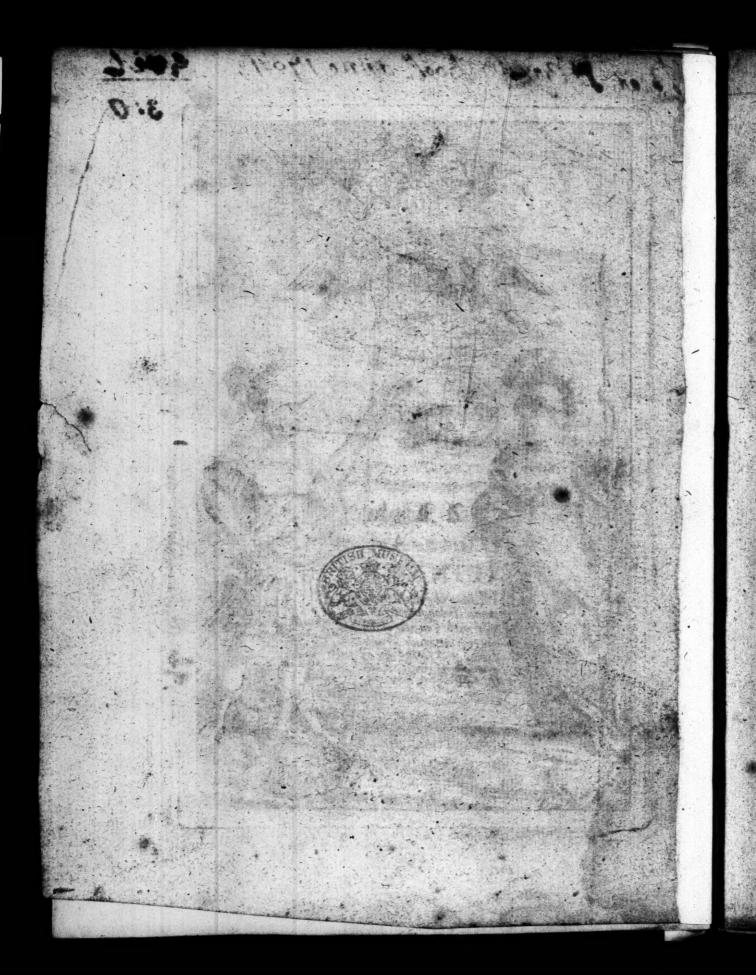
Joseph Spook anno 1404 4006





A

## LIGHT

TOTHE

# Art of Gunnery.

### WHEREIN

Is laid down the True Weight of Powder, both for Proof and Action, of all forts of Great Ordnance.

Also the true Ball, and allowance for Wind

### WITH

The most necessary Conclusions for the Practice of Gunnery, either in Sea of Land-Service.

### LIKEWISE

The Ingredients, and making of most necessary Fire-Works: As also many Compositions for the Gunner's Practice, both at Sea and Land.

By Capt. THOMAS BINNING.

LONDON,

Printed for R. Mount at the Postern on Tower Hill, 1703.

le faid aloubit that "Pauch Weight of Powder, GOTTA LECTION TO THE and content to be that content and The large thates, and in the art with eccessive the feet is all a common the contractions of the contraction of the contractions of the contraction of the contractions of the contraction of the contractio design to be gottle THE SECTION OF THE SE 201.01 The Children of the Board to Continue

### To the READER.

bave to a to that with at Popular ;

Judicious Reader,

Am persuaded there are none, tho but mean Artists, that will question the worth of the Art of Gunnery, being founded upon the two principal Pillars of the Mathematicks, viz. Arithmetick and Geometry. For by this Art, and good Artists, the Artikery bath gained Battels, Towns, Castles, Citadels and Forts; yea, the Brong Trenches of a strong Army forced, opened and formed by the weaker Army, to the ruine of the Intrenched Forces; which was feen at the Battel of Lutzen, in Novemb. 1621, where the Serene and Potent Gustavus Adolfus K. of Sweden was killed; for there the Swedes Gunners did fo artificially ply their Ordnance, that the Swedes Army stormed the Imperialifts in the most secure Trenches that could be made, and a stronger Army within than those without; and only by the Artificial and Industrious Carriage of the Gunners. By which you may perceive, that there is as much lieth on the using of the Ordnance, either by Sea or Land, to the safety of the Ship, Garison, or Army, and annoyance of the Enemy, as upon any thing elfe.

In this little Piece you may find the framing those Draughts, the calculating shose Tables for Powder and Ball, and laying out those Height-Rules both for Powder and Shot, the true Wind of every Gun, with the Dimensions of their Fortistications in giving Powder, not having regard at all to the weight of the Peece; further, as for the Draught of the Ordnance; likewise what is useful to a Gunner either by Sea or Land, and how the Gunner may lay or level his Peece to shoot at a Mark; also several Questions a Gunner ought to give some account of eve he be admitted: As also to use his Mortar-Piece and Pettard, with Fire-Works Offensive and Defensive: Whereby I am persuaded, any that will take notice of the use of the Quadrant and Quadrat, and Observations thereon, will find as Artisicial Recreations in this little Piece, as in any hath been written hitherto on this Subject.

### To the Reader.

It is visible, the great harm that cometh by breaking of Guns in siring, is the ignorance of those Gunners, and the great allowance of Powder; for if a true-fortisted Peece of Ordnance shall have to 9 th Ball 7 th of Powder; the Question is, What ought to be given to a Reinforc'd Peece shooting the same Ball? This and other such Businesses moved me to write, that thereby Gunners might be more circumspect.

I have not done this, that thereby I may add any thing to the Artificial Gunner, but that the younger Brethren may, by reading and objerving what is here made plain, learn to do their Duty.

If this Piece do instruct any yet ignorant, I shall be glad; if it please the Readers fancy I have content; but if it displease any critical obstinate Maligner of the Art, I shall take no more notice of him, but desire he may amend himself and this also: Nevertheless conclude as thou findest, and consider the good will of

Thy Friend, T. B.

### To the Praise of his Country-Man Capt. Thomas Binning.

No this little Book I plainly fee Inventions rare, with Art of Gunnery, Grounded upon two Pillars that must stand, While God and Nature Earth and Sea command, Ar'thmetick, Geometry, with new Inventions, Thy King and Countries Good, being thy Intentions. Therefore Minerva claims Ingine and Wit, And Mighty Mars does own this subject fit. Seeing from our Country-Man it doth redound. (Whose Country hath been formerly renown'd) Let us not keep from him deferved Bays, Which Strangers would afford as his due praife, Because he hath given a Light to Gunnery; Not craving therefore Gold or other Fee, I do conclude, the like hath not been wrot, In any Language, till now by a Scot. Tho. Orquart.

## An Introduction to the GUNNER, for his better Understanding.

An furrible Figure to the Gunder

Here are many who do intrude, and also that have obtained the preferment to be Gunners, either of Garisons or Ships, who never understood any the meanest or least Article (as I may say) in the Gunners A. B. G.

I speak not this to discourage any from ingaging in the Employment of a Gunner; But I am sure, except he be qualified with the Principles and Ground-Rules of Gunnery, he cannot be worthy of the place. And yet there is more than Art or Action to be obtained ere they begin: For which Cause I will here begin with those Qualifications, that a Man professing, and dignified with the trust of a Gunner's place, ought to have.

1. That he be one that feareth God more than his Enemy.

2. That he be educated, and expert in his Profession. For Experience confirmeth, some say, teacheth Art.

3. That he be constant, and not given to change.

4. That he be Faithful, True and Honest.

The Reason wherefore my first Discourse is of Gunners, is only because many times it falleth out, that most Men employed for Gunners are very negligent of the fear of God. Many Examples of this nature might be alledged and produced from the fad Experience of preceding times: But I thought good to intimate only this one, for the terrifying of all Godless, and the confirming all Godly Gunners: Which Example I had from Seyger van Reghterne, General of the Land of Overyssel, in his Diurnal from Amsterdam to East-India; the which Diurnal begun on the 8th day of December, in the Year 1628, from Texel, and ended there at his return the 12th of July 1633. In the 38th Folio of that Book, he faith, That in the Year of our Lord 1631, in the Month of April, There was on the Island Nero, a Gunner, whose Name was Cornelins Slime, but a very Godless and profane Man, who at no time could speak but he would be Curfing or Swearing; and when any would ask him what was his hopes after this Life was ended, his Aniwer

Answer was, It may be to Heaven, or it may be to Hell; but, said he, if I do go to Hell, there I will sell Tobacco and Brandy, and that would be good Medicine for the Devils. But one day this Cornelius Slime, in presence of my Author and many more, being Cursing and Swearing, and many times giving himself to the Devil; In the mean time, in presence of all those People, the Devil lift him up in the Air, and let him sall to the ground, with a great noise; but the second time being taken up by the Devil, he was carried where never Man living could find him. From the like the Lorddeliver us all. But if Experience had not taught me, both in this Country and others, what the lives of many Gunners are, I would have said nothing of it here.

Now for the Education of Gunners in their Profession, it was manifest that there were not any of the Gunners imployed by the Officers of the Army, in our King's and Countries Service, all the while his Majesty was in Scotland, which were capable of their Duty, or knew any thing of Art; and it was no Wonder to fee our common Gunners to flothful to attain to perfection in Art, because if there had been a Man able in his Profession, our Officers of Artillery would not imploy him, left he should see, and so reveal their own Insufficiency. Likewise they needed not care what their Abilities were, for those that had charge over them, durit not put them to examination, for fear their own Infufficiency should be openly known; but if they had been able to put them to it, we might expect to be better Masters of this Art, when now we are scarce good Scholars. Likewise when there were able Men in the Country, they could have no Imployment; and for fear they should be imployed, there was one Calumny or another raifed to their prejudice; either he is proud, or a Malignant, which was in effect, he was a true Subject, and therefore not to be imployed; and any of these two Names were enough to keep him from Imployment; or if he was in Service, to caule him to be cashier'd, as the Case then stood.

But to encourage Ingenious Spirits to study Art, and to practife the same, Remark what is said of the Emperor Domitian, That he was so skilful in shooting, that let a Boy a good distance off hold up his Hand, and stretch forth his Fingers, and he would shoot through betwixt his Fingers with an Arrow, and not touch the Boy. Now I am sure, that although the like may not be done with any great Piece of Ordnance, yet I have seen one, who shooting with a great Piece, within point-blank of the same Piece, after Observation and Tryal of that Piece, would shoot within a hand-breadth of any Mark; yea, set a Drinking-cup on the end of a Pike, he

would

would take it with a Ball. And because I have been both at Field, and Sex-Service, and have seen such Errors in Gunners, my Desire is, That those that are in Place, or shall come to it, may exercise themselves, and study to better their own Credit, and act something for the Benefit and good of their Country, and honour of their King.

As for the Constancy of Gunners, and others; Hath it not been feen fince the beginning of those comfortless Troubles in these Nations, the unconstancy and instability of Men, how they have varied from the one Party to the other? yea, they have for Ambition, and greediness of Gain, fled from the Army they have been fworn to, and gone to the Enemy, to the great loss of their own Souls, and hazard of the Truth, and an undoubted Advantage to the Enemies of his Majesty.

the charge of them; for were they drawn to an account of what they receive, and how they have from it, then Men durit not but be honest.

But the Commissary taking from each Barrel 10 or 12 pound weight of Powder, the Gunner finding this, must be let slip with as much; and I think 20 or 24 pound in the hundred, is a large. Intromission. Probatum.

Now to help this great, and I may say, terrible Thest committed against King and Country; and that the Ammunition may redound to the prosit of the Country, which is the only Service his Majesty requires, chuse honest Men for Commissaries, and Keepers of the Magazine, who will require an exact Account of what is gone on spent, and let every Man be content with his Wages. It is a true-saying, and the Word of God clears it, Biessed are the Peace-makers, for they shall be called the Children of God, Mat. 5. 9. Wherefore all Men ought with all their Hearts, to cry to God for Peace with Truth, the which I pray God to send us.

To any vers'd in Military Affairs, is known the great Gain or Loss which may redound either to the Country, Army or Fleet, by the well or bad management of the Great Ordnance, or Train of Artillery; for which cause, I say, it is most necessary to try such Men you chuse to be Gunners ere you trust, either for Land or Seasorvice: And if they be qualified with these forenamed Marks, then are they sit to act the part of a Man: But it is God by whom increase must come.

Now if there should chance a Man of good Qualifications to be admitted for a Gunner, and but meanly expert: To them I say, If they follow these following fundamental Rules and Instructions, I hope they shall have pleasure and profit.

As

As it is without all question or contradiction, that there is nothing more holy, more profitable or necessary than a peaceable Condition; for Peace is the nearest thing to God; in regard where Peace is there is Love, Charity, Faith, and all the Vertues: Therefore we ought to pray for Peace, that so living in obedience to God, our King and Rulers, we may prosper in this World, and live in Blifs eternally.

But in regard that the great Princes of the World may observe and feek Peace, we ought to pray, That as God hath placed them hi Power, to he may direct them in all their Actions, to do nothing contrary to his Glory, or the good of their Subjects. For what divifion amongst the Kings and Princes in Christendom, hath done to the destruction of Religion, effusion of Blood, and ruining of their Estates, is much in Histories made plain: And what hath been done by our unnatural Divisions within these three Kingdoms, is yet fresh in memory, to the great grief of many good Christians. And in regard that fome Princes in Christendom are forced to keep War, for maintaining of the Christian Faith against Turks, Suracens, and barbarous Tarters: As also that amongst themselves; some are either blown up with Pride or Envy, who would Reign alone, much amufing the minds of Men what they intend to do; so that War is as like to be as ever. Therefore any well-wishing Person ought to study for the advancement of his King's Honour, and good of his Country.

Now what may be the Actions done by great Ordnance in time of War, may be thought either needless or hurtful: Because there is nothing thereby to be taught, but to raze down Fortifications, and other Strengths, to ruine: Or how an Army, by cutting off the Souldiers, may be shattered and broken, and an intrenched

Leaguer may be broken up and forced.

fruly such Men ought to be in esteem, if we will have any respect to these dangerous Times wherein we live, they ought to be encouraged; because no Potentate can be longer in Peace than his Neighbour pleaseth: and that scarce any Strength is able to resist the sury of terrible Cannon well managed.

And amongst all Arms in time of War the great Ordnance is first in use, whether it be against, or in a beleaguered Place; and especially when they are rightly managed with Discretion, they are

both helpful and encouraging to their Party.

And contrary, when they are not Men of Judgment and Discretion, but slothful, and ignorant, then they produce Damage to the Owner of them. For, as History declares, the great Ordnance hath been the only Winners of the Battel sometimes, and great Victory,

when they have been well managed, while the opposite Party gave their Ordnance only the blame of their flight, because they were not we managed.

What a Gunner ought to be, to whom the Charge is committed, and what he ought to know.

As it is necessary in all Fortified Places, as well in time of Peace as of War, to have able practifed Gunners, who are able to give an account with reason of the things belonging to their Charge; and that they be such as fear God more than their Enemy, they ought to be honest, and not given to change, as afore is said.

The Gunner ought, befides his true shooting, to be learned in A-rithmetick and Geometry, which will cause him give Advice where a Strength may be most conveniently battered, and what Ordnance is

most fitting to accomplish the same.

Also he ought to give Directions to the Engineer, what form of Batteries is most convenient at such and such places: Likewise by his Art he give Directions, that a Storm be made where his Party may have the least harm, by his playing with Ordnance upon the Places where Danger is to be seared: Likewise if in a beleasuered Place, the Gunner is to defend the same against opposition of the Enemy, and to order so, as by the assistance of the Ordnance, and by what other means he can, to oppose and destroy the Enemy for defence of the Place.

But before all things, and before the Army approach to the Place, to which the Prince, General, or other Officer who commands in chief, do intend to beleaguer or take; It is necessary that the experienc'd Gunner be one to go before, and view the Place, with the Ground thereby; the which to do, is best at breaking of the Day in the Morning, to know if the Walls be strong or weak, and how and by what means they may be brought down; as likewife to find if that Fort or Garison be so fortified, as to annoy the Ground, or what part thereof is most fecure for the Army to lay down Leaguer; and what Ground is best to annoy the Enemy most in the Garison, and also what place of the Walls thereof is best to Batter and Storm, and which way most secure to bring the Scaling Ladders to set up; and to know if there be any Mount, Steeple, or high Building within that is Fortified, to over-look the Leaguer; for by fuch means great harm may occur, (or near the Leaguer) where the Enemy may over-look and relieve the Belieged, and io cause the Leaguer to rise;

except the Ordnance in the Leaguer be capable presently to disorder and deface the same, that after the Leaguer is intrenched, it may be defended by Ordnance, &c. Then he must know if the Ground be diggable, and on what Side of the Leaguer the Proviant may be best and most fecurely brought in, and what fresh Water is there-about for their relief within command of the Leaguer-place: So when it is known where, on what end of the Place or Side the Great Ordnance must be placed, and lie from or in the Leaguer, then must the Batteries be drawn out and measured; and because it is hazardous to work on a Plain, to break Ground before an Enemy, but there must Blinds be raifed, some must be where you are not to work, as well as where you intend to build your Batteries. But if you be on fuch Ground where you must begin your Approach at a distance, then you must know at what distance you may with conveniency break Ground to run your Trenches for Approach; and as it is certain the Point-blank Diffance of a Peece of Ordnance is 220, 230, 240, 250 Geometrical Paces, which is also the distance of a Musquet-shot: Therefore the knowing Gunner ought to give the Workmen order, if there be no other Engineer for the Effect; and in this regard the Gunner ought to be acquainted in furveying for this, as well as for his Batteries and Ordnance placing: For if one would begin an Approach, then he must chuse out so many Souldiers used to Work, as may be able to defend themselves and refist a Sally, if any be: Not neglecting to have Parties both of Horse and Foot about the Ground to defend them, in regard they are to carry, besides their ordinary Arms, Shovels, Pickanes, Gavelocks, Crows, and what is necessary for their Work. At the place commanded to break Ground, it is fitting to cast up a Redoubt or two, from whence the Trenches are to begin; and run the Approaches, that if any fuddain Affault come, the Workmen may retire thereto and defend themselves, and work till they have affiftance: for if the Workmen had no place of prefent retreat, they would be forced to sun and leave their Work, Tools, and Arms, to the Enemy. To this purpose it is to be observed, That the expert Gunner, or Engineer, who is employed in this Work, is to use all the Art, Skill, and Experience they have, to run their Lines in fuch fort, that those which are in the Trenches and Approaches may not be discovered and seen by the Enemy, so that with Safety and Expedition they may approach near the place, or part of the Fortrels, which the General defires to become Malter of

For now in our Modern Fortifications, there are but two parts in a Town or Fortress, of which one must be battered if they mind to take it in; and these are either a Bulwark or Curtain. When

When the General or Commander of the Field by Advice of the Council of War, hath refolved either to batter a Bulwark or Curtain. the Gunner or Engineer being present at the breaking of Ground, is to shew and inform the Workmen how they are to run their Line, and as the occasion presents, of divers lengths; for they must be turned at every just occasion, which is most necessary. When the Line is laid out and marked, the Workmen must be divided and placed in order, that one may not hinder another: Then to give to every Workman the length of 4, 5, or 6 foot, and then begin they to hasten into the Ground, for to avoid the danger which they are exposed to, while they stand upon the Earth; Therefore the Earth which they dig, they cast up before them, and as fast as can be make a Hole like a Grave: to when they have digged three foot in the Ground, and three foot broad, then fure they are covered, fince from their Basis to the top of the Cast-up-Work there are fix foot: When they are under Covert, then they enlarge and deepen the Approaches as they are ordered: Observe, they need not be so deep at the beginning as near to the Fortress; sometimes the Trenches must be made so broad, as that the Cannons and Waggons of Provision must be drawn to the Barteries or Galleries. These Works are ordinarily begun in the Night; so when the Night is gone, there are fresh Men sent to relieve the first, and enlarge the Night Work, and amend what they could not fee wrong. After this Nights Work, or the same, there are Corps of Guard made to contain Souldiers for a Main Guard, which Work ought to be with a Line of Communication with the Trenches, though they be at a distance, viz. four or five paces distance. When one Line is finished as above-faid, and that it must be run no further that way, the Gunner or Engineer turns it another way, bearing it from the Town or Fort, and placing the Workmen as aforefaid, and fo continuing by Turnings and Windings, till he hath got something near the Place or Fort belieged, and making good the Line continually with Corps of Guards and Batteries, until they be at the brim or fide of the Moat or Ditch of the Fort: Then is the Gunner or Engineer fo to order his Business, as to begin a Sape or Gallery, or Mine under the Ground, directing his Courie by his Compais; as if Impediment of Rocks happen to stop his Course intended, he may make fuch Lines and Angles about the fame, as may bring him to his direct Line again; no rejemblance to it, but a Mariners Traverse by cross Winds at Sea.

But for the effecting of a Mine, there must be provision made of divers things necessary thereunto, as Shovels, Spades, Pickaxes, and B 2

all kind of Mason-Tools, with all things requisite to pierce a Wall wherewith the Rampier is made: Then one prepares Props to spuport and bear up the Mine from falling or sinking, being thick and long, as is requisite; likewise you must have store of Fir-Planks to line the Mine within that it may not fall down, for it must all be lined

if the Ground be frush or brittle.

Before you begin to make a Mine, it will be requisite you know the Ground of the place, whether it be vaulted or not, or on what the Foundation thereof is laid: The Miners being to break into a Wall, are to carry their Mine as close and secret as may be, that the Besieged may not hear any noise, or get any notice where the Mine is made, and how it runs; for if they do, questionless they will make a Contra-Mine or Traverse above Ground, to discover and spoil your Mine begun; so that failing, you cannot force the Besieged that way, except you begin a new Mine in another place: Such as was at

the Castle of Edinburgh.

The Master-Gunner or Engineer that conducts a Mine ought to be a Man of good Experience, left he miscarry in his Traverse; for which cause he ought to be well acquainted with the Mariners Compais, and also with the Variation thereof; for if there be a Mineral of Iron Ore in that Ground, it is like the Compais will vary, and fo milearry the Mine: He ought also, for his Lines of Traverse, to be acquainted with the Line of Chords, or Plain-Scale; otherways with the use of the Protractor, for directing his Course and Traverse in the Mine, that he mistake not himself either in his Course or Distance, Altitude or Profunditude, according to the Ground he works in, and the Foundation of the Rampart. When the Mine is brought to the entry of the place where the Chamber must be; sometimes order may be given to blow the Rubbish into the Fort belieged or it may be out into the Most or Ditch; either of which may be done by making the fide thinner, which they would break to, than the other: And our Experience is fufficient proof of this, either in Cannon or Musquer; for if you load a Piece of Ordnance, that there be a greater weight put after the Powder than in reason, give fire to the touch-hole, and you will find that Piece fly out either at Side or Breech.

The proportion of Chambers are as various as the Wall or Rampart which they are to deface, therefore can have no dimension, but they must be made so large as to contain Powder sufficient. Some would prescribe Rules for a Barrel of Powder to blow up a Rod of Earth; but the Earth being of various ponderosity, and some so much stronger bound than others, that I suppose they must use rather

more than less Powder; yet the Chamber would not be made larger than to contain the quantity of Powder ordained to open that Breach.

When an Enemy hath belieged a Place, Citadel, Fort, Castle, or other Fortification, and hath approached to Batteries; certainly it behaves the Besieged to look about them, and to do their utmost endeavour to hinder the Enemy. The Desence against these Approaches is, to strive to make some Contre-Approaches; which may be done by stoutly fallying out, but withal to fally out with Discretion, for sear of losing Men, which is to be expected; by which sallying, the least Offence you do the Enemy, is to hinder the progress of their Approaches; for if they be beat back, and constrained to sly into their Works, for so long as the Alarm endureth, they cannot advance their Work, nor begin again to work till the Besieged be retreated.

Likewise this manner of Desence may be made by Cannon, which may play from all places upon the workers of the Approaches, to do

Workmen in fear, by feeing their Fellows miserably flain by the \* Cannon, which may be a means to make them leave working till there be Batteries

\* By firing fix Comnon together over the Mine at Edinburgh Castle, it fell in.

made against the Besieged.

The Contre-Approaches, by which you relist an Enemy, that they may not become Masters of your Our-works, or Contre-scarf, with their Approaches; These Contre-Approaches, to hinder the Enemy in their approach, are made by casting up some to the Enemy in their approach, are made by casting up some to the Flaverse I against the Approaches of that Rebellious Army, running them so as to find the Enemies Mines. The Lines of this Traverse must be cast up toward the Enemy, but lest open to the Besieged, or Garison, because by them they must be defended: This Traverse must be so made, that it give no Advantage to the Enemy if they take them in; and be sure they may be slanked both with Cannon and Musquet from the Fort or Garison.

so that as there is an Offensive War, there is also a Defensive War, as doth appear by Mines; for the Besieged having discovered them, and got into them, may lawfully kill the Miners: Now when the Besieged have found the Mine out, it is to be known how they may make the way clear before them, and either kill the Miners, or make

them fly, without having the least harm.

After the causing a Hole to fall in their Mine, near to my Traverse, I prepared a Powder-Barrel, with old Rope-yarn, Mens Dung dry about the Walls, Powder meal'd, Brimstone, and Verdigrease, with

Cam-

Camphire; all which being mixed together, I caused to be put in the Mine, which made Overton (then Governour of Edinburgh) and all fly: So we entred peaceably, and brought thereout their Working Tools without any harm.

For the Gunner's further Knowledge, that is yet in his Minority. this Work is begun with Decimal Arithmetick, which is very ufeful in the Art of Gunnery, the working and extracting of the Square and Cube Roots; as also some Definitions and Problems of Geometry: by which the Gunner may the better make use of his Compasses, for which he will have several needful uses; for the whole Matter, I know little in this Book that may be wanting in a Gunner, that may be called a fufficient Gunner. In fine, know, that I shall be glad that every Gunner may profit by it, and I wish that some may amend it. However, know, that I intend this for your Profit and the Publick Good: for if I had not feen need. I would never have taken the Pains, nor been at the Charges; but (understand me right) no Pains can exceed the Duty we owe to our King and Native Country. So wishing every good Subject to employ the Talent he hath received of God, to the Honour of his King, and Good of his Fellow-Subject: Committing the Book to thee, and thee to God Almighty,

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THOMAS BINNING. 

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### Decimal Arithmetick.

### CHAP. I. Definitions.

Fraction or broken Number, is a Number less than an Unite, or One; and according to the common way of Fractions, is expressed by two Numbers set one over the other with a small line, thus, ‡; the upper Number is called the Numerator, and the lower the Denominator.

The Denominator sheweth into how many parts the Unite or

Whole of any thing is to be divided.

The Numerator sheweth how many of these parts are signified by the Fraction.

A Decimal Number is that which is expressed by an Unite, with a Cipher, or Ciphers, as 10: 100: 1000: 10000: 10000: 6c.

A Decimal Fraction is that whose Denominator is a Decimal

Number, as 13: 100: 7000: 100000 : 1000000 : 000.

Decimal Fractions, whether they stand alone, or be joined with Integers, have always a Comma, or a small Rectangular Line before them, to distinguish them from Integers, which is therefore called a Separating Line, as 14, 136, 1348, 412, 4901086, &c.

As in Integers the Value or Denomination of Places do increase by Tens, from the Unite place towards the left hand: So in Decimals the Value or Denomination of places do decrease by Tens, from the Unite

place towards the right hand: As in the Table following.

### The TABLE.

of Hundred Millionths.
of Hundred Millionths.
of Hundred Millionths.
of Hundred Thousandths.
of Hundred Thousandths.
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of Hundredths.
of Hundredths.
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of Hundreds.
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of Hundreds.
of Hundred Thousands.
of Hundred Millions.
of Hundred Millions.
of Hundred Millions.

In Decimal Fractions, the Numerators are only fer down, without the Denominators; but the Denominators are easily known, for they they are the same with the Denomination of the last Figure of the Numerator. As in the Examples following.

### CHAP. II. Addition and Subduction in Decimals.

A Ddition and Subduction in Decimals, whether in pure Decimals, or in Interest mixt with Decimals, differ not from Addition and Subduction in Integers, only care must be had to place the separating Lines of the Numbers under one another; as also the places of like Denomination under one another; and the separating Lines of the Sum or Difference, must be placed under the separating Lines of the Numbers added, or subducted. See the Examples.

L347	SE LOS	L897	SELECTION OF THE PROPERTY OF T		5[98
L149		L643		THE RESERVE OF THE PERSON OF T	4L2 5L934
		T.79			F8
L764		3L130		-	Lo7
				42	8[984

In Addition and Subduction, let the place of the Fraction remain fo many places as they were, and no more. See the Example.

Addition		Subdu	Etion.
35L72		78	.25
78L05		35	75
100			-
113177	THE PART OF	42	50

Examples

Examples in Subduction.

L724 - L89	[6427  c48	641279
L482 - L5796		48[384
L242 L3104	L2827	15[895
46[2 59[872.	74L0 (200	3412
91746	65F08 0285	L642
361454 521972	81,02	33L558

### CHAP. III. Multiplication in Decimals.

THE Numbers to be multiplied together are called Factors; and the Number found out by Multiplication, is called Product.

Multiplication, whether in pure Decimals, or in Integers mixt with Decimals, is the fame in operation with Multiplication in Integers: The last Numbers of the Factors must be set one under the other, as if they were Integers, not regarding the placing of the separating Lines under one another, as in Addition and Subduction: And from the Product must be cut off with a separating Line so many of the last Figures, as there are places of Decimals in both the Factors.

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2568 1:09 bines in	1708	978	2016
3210 1111 1011 3970 0	1281	2934	1008
L34668	141518	301318	120196

If it happen, when the Multiplication is ended, that there be fewer Figures in the Product, than there are places of Decimals in both Factors (which may often occur when the Product is a Fraction) in such case, as many places as are wanting, so many Ciphers mult be prefixed to the Product on the left hand thereof, and then a separating Line must be prefixe to sign the Product so increased for a Decimal. See the Examples.

- Lo37	gen night ad	1 01-00-515	is a taylor of	12653
Los	25	Loo	fuerer the 197	L00045
18	75		10	63265
750	3	1105		50612
L00093	75 1	LO1436	I formany (O)	100569385

In Multiplication with Fractions, cut off fo many places as there are Figures of the Fractions, in the Multiplicand and Multiplier.

### Decimal Arithmetick.

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.642	12820 80 30	439230	order.	
381558	5013	146410	61.45+	
general me a hallon han select and the g	1400L585	1930411585	man	
	pilitation on Decimals.	Will Mascar, 10)		

### CHAP. IV. Division in Decimals.

I lvision, whether in pure Decimals, or Integers mixt with Decimals, is the same in Operation with Division in Integers. But care must be had to give a true denomination to the first Figure of the Quotient; (according to this Rule.)

The Rule. The first Figure of the Quotient is always of the same denomination with that place of the Dividend, which stands, or is

fupposed to stand over the Unite of the Divisor.

It will happen sometimes, that the Unite place of the Divisor will stand beyond all the significant Figures of the Dividend, towards the right hand, or towards the left. In this case you must put Ciphers to the right or left of the Dividend, until you come over the Unite place of the Divisor. See the Examples.

If 3147 is to be divided by 01000462, they must stand thus;

And the Denomination of the first Figure of the Quotient will be thousands of Integers.

If 34 is to be divided by 642[79, they must stand thus;

And the Denomination of the first Figure of the Quotient will be hundreds of Decimals.

Note: That what Ciphers are added to the right hand of the Dividend, immediately next the Integers, must have a separating Line (or a Comma) before them.

In Division, the Fractions being equal, the Work is as whole Num-

bers are.

vampes.

If unequal, add so many Ciphers to the Dividend, as the Fraction of the Dividend in places, that you may find your Fraction in the Quotient.

Exam-

### Decimal Arithmetick.

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	5000	<b>≺Therefo</b>	ore I add two	Ciphers>
the Side of	2200	As in th	Dividend.	ple o o 9
If in Division				7
a Table for ther	I be to divide in.	Exam	Me.	may make
Which is don	ie, first doublin	g of it, then a	dding it until 1	ine times,
if I will ten, w	94[000/1192]	oadi that like	s propoled:	all Square
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quares, You mult efullowing Carr	Con <b>230301</b> 5	ts or Sides of	tract all Roo	to of the w
SAHO.	-2410	G 2		Because :

Because the Fraction is three Figures in the Divisor, therefore I add three Ciphers to the Dividend. As in this last Example.

CHAP. V. Of the Square Root.

A Square Number is that which is made and produced of two equal Numbers multiplied together, or else of one Number multiplied by it self; as 16 is a Square Number, because it is produced of 4 by 4, (which are Numbers equal, or one Number multiplied by it self) likewise 25, 36, 49, are three Square Numbers, for they are Products of the Multiplication of two equal Numbers, or of one Number multiplied by it self, as 5 by 5, 6 by 6, and 7 by 7. For the Products may be understood by their Unites in a Plane, of such kind as shall represent the form and figure of a Geometrical Plane, as you see here-under.

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It is evident by the generation of Squares, that you may make a Square of all Numbers given, and that you may extract the Root of all Squares proposed; and that likewise all Numbers proposed may

be the fide of fome Square or another.

There is a Double Root and a Double Square, viz. Simple and Compound; The Simple Root is that which hath but one Number, as are 1, 2, 3, 4, 5, 6, 7, 8, and 9; the Squares of which are called Simple Squares. The compound Root is that which hath more than one Number, as are 10, 11, 12, 20, 30, &c. the Squares of such are called Compound Squares. And before you will extract the Compound Root, you must know by heart the nine Simple Roots with their Squares, by means of the following Table.

A Table of the Simple Roots with their Squares.

[Roots. 1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 : 9]

Simple Squares. 1 . 4 . 9 . 16 . 25 . 36 . 49 . 64 . 81

To extract all Roots or Sides of Compound Squares, You must well understand and imprint in your memories the following Chapter.

CHAP. VI. Extraction of the Square Root in Decimals. N extracting the Root or Side of a Compound Square, you must first mark the Square Number given, with Points or Fricks from the right hand to the left, beginning with the first Figure towards the right hand, marking over that Figure one Prick or Point, then fet another over the third Figure, and another over the fifth; and so proceeding continually from the right hand to the left, marking still with a Prick over every third Figure, leaving the other Figures un-

marked, until you come to the last Square towards the left hand.

First find the Simple Root of the Figure or Figures that remain towards the left hand; multiply that Root in it felf, subtract it our of the Figures towards the left 322624(968 hand: Then draw down the next two Figures to that Remainder, and fay 2 times 5, the Quotient is 10; fet to under 72, and see how often it may be found in 72, 726 say 6 times; then fer 6 under 6, and fer 6 also in the 206 Quotient; then multiply 106 by 6, cometh 636, fub-636 tract it from 726, there remaineth 90 : Then draw down the next two Figures to that Remainder, and fay, 2 times coin the Quotient is 112; fet 112 under 2228 902, and fee how often it may be found in 902, fay 8 9024 times; then fet 8 under 4, and fet 8 alfo in the Quotient, then multiply 1128 by 8 cometh 9024, fubtract it from 9024, there remaineth nothing; fo that 568 the Quotient is the just Root of the Square Number 322624, 65.

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charemab was Hadride

75930 (2731553 CHAP. VIII. Letvation of 945 Cabe Root in Decha de. O premere a Cobe Number **(1885**) neraction, pet all'oid aver the first place aborded roman **the** meter hand, so the nucl nig asmanding this books made and the section of the section 30400 and the first of the control of a post and some six and and the control of passing ever the teventh, and \$1275212 orders, from the tarry places being intermeted between ever joogreed acentracions) place as higmy Polateins the Wumber will passes a crack being given, you 475525; great an emio Louis open of size 2197500 1653309 CHAP.

### CHAP. VII. Of the Cabe Root.

Cube is a folid Body, comprehended of fix equal Square Superfices, and is like unto the Dye of a Table-Board.

### Definition me the third Flour motinate

Every Number multiplied in it felf maketh a Square Number, of which the Root or Side is the Number multiplied; and every Square multiplied by its Root, maketh a Cube Number, (by the 20th Definition of the 7th Book of Enclide:) As a times 4 makes 16. (a Square Number, of which the Root is 4) the which 16 being mulriplied by the Root 4, the Product giverh 64, a Cube Number, of which the Root is 4. course own the next two brand : band

Likewife s times s maketh 25, a Square Number, which being multiplied by its Root 5, the Product giveth 125, a Cube Number. of which the Root is s, and so of others. And before you can extract the Compound Cube Roots, you must first know the nine Simple Cube Roots, with their Squares and Gubes. As appeareth in the following Table, which is divided in three Lines, whereof the first (which is the uppermost) containeth the nine Simple Roots: and the second Line (which is the middle Line) containeth the nine Squares; and the third Line, which is the lowest, containeth the Cube Numbers. more than that they are by B. Com-

A Table of the Simple Roots, with their Squares and Cubes.

Sides. Squar Cube	1 2 2	196		quare	. 6	100	7	8 31	• 9
号 (Squar	res. 1 . 4	9		16 . 29		6 .	49 .	64	. 8t
₹ Cube	s. 1 . 8	3 . 2	27 .	64 . 12	5 . 2	16.	343 .	512	. 729

### CHAP. VIII. Extraction of the Cube Root in Decimals.

O prepare a Cube Number for Extraction, put a Point over the first place thereof towards the right hand, (to wit, the place of Unites;) then passing over the second and third places, put another Point over the fourth; and passing over the fifth and fixth, put another over the feventh, and in that order, (to wit, two places being intermitted between every two adjacent Points) place as many Points as the Number will permit: So 157464 being given, you are to place the Points as here followeth; and so many Points as are in that manner placed, of so many Figures the Root demanded will confift.

Having

Having thus prepared your Number, you may fee it diffributed by the Points into feve-us . T XISU & STORY ral Cubes: So in the fame Example 157 is the 157464 (54 first Cube, and 464 the second.

First, Find the Simple Cube Root by the -preceeding Table of 137, which is 4; fub- 32464 Refolvend. fcribe the Cube of that Root under the first Cube of the Number given; fo 124 being the 75 Cube of the Root, I write it under 197 the 15 first Cube of the Number given, and subtract this Cube from the first Cube of the Number 765 Divisor, propounded, placing the Remainder orderly underneath the Line: So 125 the Cube of 5, 300 being fubtracted from 157, the Remainder is 240 32 : to the faid Remainder, bring down the next Cube of the Number propounded, (to wit, the Figures or Ciphers which stand in the 32464 three next places) placing the faid Cube next after, to wit, on the right hand of the remainder; to the next Cube 464 being placed after bubor his long ad in

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the Remainder 32, there will be found the Number, 32464, which, may be called the Refolvend. Having drawn a Line under the Refolvend, square the Root in the Quotient, that is, multiply it by it; felf, and subscribe the Triple of the said Square or Product, under the Resolvend, in such manner, that the first place (to wit, the place. of Unites) of the faid triple Square, may fland directly under the third place (or place of hundreds) in the Resolvend: So the Square of the Root 5 is 25, the Triple whereof is 75, which I subscribe under the Resolvend in such manner, that the Figure 5, which is in the first place, (to wir, the place of Unites) in the Triple Product 75. may stand under 4, which is seated in the third place of the Resolvend. Triple the Root of Number in the Quotient, and subscribe this Triple Number in fuch manner that the first place thereof, (to. wit, the place of Unites) may stand directly under the second place. (to wit, the place of Tens in the Resolvend: So the triple of the Root 5 is 15, which I subscribe in such manner, that the Figure 5, which is in the first place (to wit, the place of Unites) in the faid triple Number, doth stand directly under 6, which is feated in the second place of the Resolvend. The triple Square of the Root, and the triple of the Root being placed one under the other as is directed, draw a Line underneath, and add them together in fuch order-

as they are feated, and let the Sum be esteemed as a Divisor: So the triple Square 75, and the triple Number 15 being added together. as they are ranked in the Work, the Sum will be 765 for a Divisor: Let the whole Resolved, except the first place thereof towards the right hand, (to wit, the place of Unites) be esteemed as a Dividend; then demanding how often the first Figure (towards the left hand) of the Divilor is contained in the correspondent part of the Dividend, and observing in that behalf the Rules before taught in Divifion, write the Answer in the Quotient : So I ask how often 7 (the first Figure of the Divisor towards the left hand) is contained in 32. (the correspondent part of the Dividend placed above) the Answer will be 4, wherefore I write 4 in the Quotient : Having drawn another Line under the Work, multiply the triple Square before fubscribed by the Figure last placed in the Quotient, and subscribe this Product under the faid triple Square, (to wit, Unites under Unites, Tens under Tens, &c.) So 75 being multiplied by 4, the Product is 300, which I subscribe under 75 (the triple Square,) Multiply the Figure last placed in the Quotient, first by it felf, and then the Product by the triple Number before subscribed; this done, subscribe the last Product under the said triple Number, (to wit, Unites under Unites, Tens under Tens, &c.) So 4 being squared or multiplied by it felf, the Product is 16, which being multiplied by the triple Number 15, the Product is 240, this therefore I subscribe under the aforesaid triple Number 15. Subscribe the Cube of the Figure last placed in the Quotient, under the Resolvend, in such manner that the first place of this Cube, (to wit, the place of Unites) may frand under the place of Unites in the Resolvend: So 64 being the Gube of 4, I write it under the Resolvend 32464, in such manner, that the Figure 4, which is in the place of Unites in the Cube 64, may stand under the Figure 4, which is seated in the place of Unites of the Refolvend. Drawing yet another Line under the Work, add the three last Numbers together in the same order as they are seated, and subtract the Sum of them from the Resolvend, placing the Remainder orderly underneath: So the Sum of the three last Numbers, as they are ranked in the Work, is 32464, which if you subtract out of the Resolvend 32464, the Remainder is o. Thus the whole Work being finished, the Cube Root of 157464, (the Number propounded) is found to be 54.

Note 1. When the Sum of the three last numbers before mentioned is greater than the Resolvend, the Work is erroneous, and then you are to reform it by placing a lesser Figure in the Quotient. Note 2: For every one of the particular Gubes (distinguished by the Points) except the first Gube on the left hand, a Resolvend is to be set apart, by bringing down to the Remainder the next Gube. And as often as a Resolvend is set apart, so often is a new Divisor to be sound, by adding the triple of all the Root in the Quotient (consisting of what Number of places soever) to the triple of the Square of such Root, after they are orderly placed, according as is above-mentioned.

Note 3. The Work of the Table of Simple Cubes in Folio 6, for finding the first Figure of the Root (as before declared) is but once used in the Extraction of the Root of any Number whatsoever; but the Work of all the following Rules is to be used for the finding of every place in the Root except the first.

The practice of these three Notes will be seen, when we describe

how to extract the Cube Root of Numbers not Cubical.

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### CHAP. IX. Another Example wrought by the Genitures.

OUppose a Number given to be 16387064; of which the Cube Root is required . First, you must cut the Cube given into Ternaries from the right hand to the left, (as was declared in Chap. 8.) Then find the Root of the first Cube from the left hand 16, whereof the greatest Root is 2; for 2 being multiplied cubically, giveth 8, the which 8 being deducted from 6, the first Cube of the Number propounded, there remaineth 8, then fet the Root found 2, with the Square thereof above it, and by the fame the Geniture, and then find a fecond Figure for the Root of the fecond Cube, and you shall have 5, which ye shall fet down with its Square and Cube under it, right against the Geniture towards the right hand; then multiply each one by another, and add the Products together, there cometh 7624, which being subtracted from 8387, there doth remain 762. In the lame manner find a Root for the Numbers remaining to be extracted, and it shall be the Root of your third Cube; And the Example will stand thus:

And feeing there demaineth nothing, it is manifest that the Number propounded 16387064 is a Cube Number, and the Root thereof is 254, by the 4th Proposition of the second, and 20th Definition of the feventh Book of Enclide at hospion A a se nano amba A

When we come to calculate the Table of Cubes, by which you may make an Inch Rule for height, or Line of Diameters, the way thall be described how to extract the Cube Root of Numbers not Cubical, or, as they are termed, Irrational Numbers, from which no true Root can be obtained, yet many times the Error will not be part of an Unite. of a to Hall to supply had ad puther uled in the Parention of the Root of any Murther whatfoever

### CHAP. X. Principles of Geometry.

Here are divers Reasons which make me to give these few Principles of Geometry, because the whole Work of this Book, is either to be done by Arithmetick or Geometry; and belides that a Gunner cannot obtain to know the truth of a Diameter of a Ball. except he can Geometrically extract the Wind of the Bore of the Piece, and thereby find the Ball fitting fuch a Piece : And in general will be most useful for any Gumer. I had and to soo! and bed med T of the greatest Root is a for a bec

### the which 8 being deducted initial of the first Gube of the Number

- 1. A Point or Prick, is that which is the least of all Materials, and it is the beginning of Things, as being void of Length, Breadth, and Depth, having neither Part nor Quantity, (expressible in Numbers,) and therefore it admits of no Division, but that which is mental only. This Point or Prick is represented unto you by the Letter A. Thus A.
- 2. A Line is a Magnitude extending it felf in length, without breadth or thickness, (whether it be a streight Line or crooked) and (in respect of its length) may be divided into Parts, but will admit of no other division, but in length only. As is fet forth to you by the Line BC; the extremities whereof being Points, as B and C.

3. A Right or Straight Line, is the nearest Distance that can be betwixt two Points; As in the former Line BC.

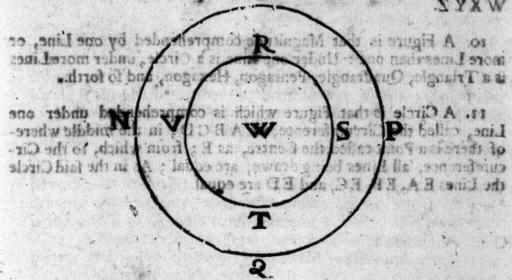
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4. Circular

od no further than Right Lines, us are tongen, though they be extended no further than Right Lines, us are the Lines DE and F Greet but



-draught from one Line to and or : As in the preceding Figure



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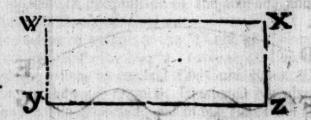
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two Gircles, viz. NOPQ and RSTV, being both drawn upon the same Centre W, and therefore are parallel one to another.

7. A Superfices is the second kind of Quantity, and to it are attributed two Dimensions, Length and Breadth, but not Thickness, for

for a Superfices is the term or end of a Body, as a Line is the end and term of a Superfices. As W X Y Z is a Superfices, and to be



8. The Extreams of a Superfices are Lines; as the Ends, Limits or Bounds of a Line, are Points confining the Line: fo are Lines the Limits, Bounds and Ends inclosing a Superfices; as in the foregoing Figure you may see the Superficies inclosed with four Lines, viz. YW, WX, XZ, and YZ, which are the Entreams or Limits thereof.

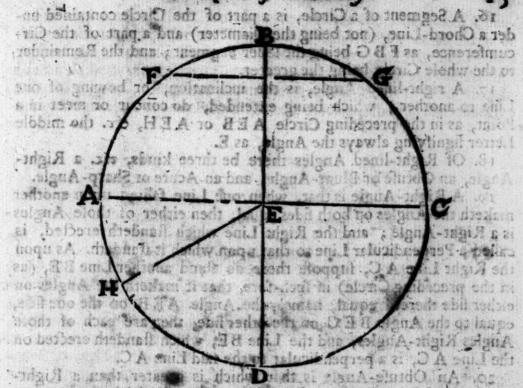
9. A plain Superfices is that which lyeth equally between his Lines, like as a Right Line is the shortest extention or draught from one Point to another; so a plain Superficies is the shortest extention or draught from one Line to another: As in the preceding Figure W X Y Z.

no. A Figure is that Magnitude comprehended by one Line, or more Lines than one: Under one Line is a Circle; under more Lines is a Triangle, Quadrangle, Pentagon, Hexagon, and so forth.

Line, called the Circumference, as A B C D; in the middle whereof there is a Point called the Centre, as E; from which, to the Circumference, all Lines being drawn, are equal; As in the faid Circle
the Lines E A, E B, E C, and E D are equal.

coll. General College and RSTV, being both drawn spon the annie Centre W, and therefore are parallel one to monitor.

7. A Superfices is the fecond kind of Quantity, and to it are attributed two Dimentions, Length and Breading, but not Thickness.



Angle, prince Angle Hit; is (in all precising Circle) to 12. The Diameter of a Circle, is a Right Line drawn through the Centre thereof, and ending at the Circumference on either fide, dividing the Circle into two equal parts : As the Line AEC in this Circle is the Diameter thereof, because it passeth from the Point A to the Point C, and so likewise through the Centre E, and divideth the whole Circle into two equal parts.

13. The Semi-diameter being the half thereof; as AE and EC. the one Term whereof being the Centre, and the other the Circumference : It followeth by the 11th Definition hereof, that all Lin drawn from the Centre to the Circumference are equal; Therefore

is B E and E D likewife Semi-diameters.

14. A Semi circle is a sigure which is contained under the Diameter, and under that part of the Circumference which is cut off by the Diameter, as the Semi-circle ABC, is contained under the Diameter A.C. and also under the part of the Circumference ABC, which is cut off by the Diameter A Co laspe the a gold with tol .

15. A Quadrant is the fourth part of a Circle, or is contained under two Semi-diameters, and the fourth part of the Circumfe-

rence, as in the preceding Circle A.E B or BE C.

16. A Segment of a Circle, is a part of the Circle contained under a Chord-Line, (not being the Diameter) and a part of the Circumference, as F B G being the leffer Segment; and the Remainder to the whole Circle being the greater.

17. A right-lined Angle, is the inclination, or bowing of one Line to another, which being extended, do concur or meet in a Point, as in the preceding Circle AEB or AEH, &c. the middle

Letter fignifying always the Angle, as E.

18. Of Right-lined Angles there be three kinds, viz. a Right-Angle, an Obtule or Blunt-Angle, and an Acute or Sharp-Angle.

19. A Right-Angle is that, when one Line falling upon another maketh the Angles on both fides equal, then either of those Angles is a Right-Angle; and the Right Line which standeth erected, is called a Perpendicular Line to that upon which it standeth. As upon the Right Line A C, suppose there do stand another Line B E, (as in the preceding Circle) in fuch fort, that it maketh the Angles on either fide thereof equal, namely the Angle AEB on the one fide, equal to the Angle B E C on the other fide, then are each of those Angles Right-Angles, and the Line BE, which standeth erected on the Line AC, is a perpendicular to the faid Line AC.

20. An Obtuse-Angle is that which is greater than a Right-Angle, as the Angle HEB (in the preceding Circle) is greater than the Angle A E B, by the Angle A E H, and therefore is an Obtufe-Centre thereof, and cheung as the Circumference on ciries lid signA

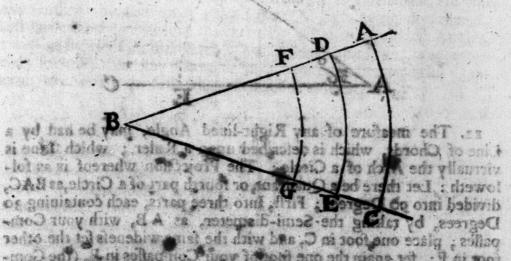
21. An Acute or Sharp Angle, is that which is less than a Right Angle, as the Angle A E H is an Acute-Angle, because it is less than the Right-Angle AED, by the other Acute-Angle DEH!

Here you are to observe, That the Circumference of every Circle doth differ from the Circle, as that which is contained doth differ

from that which containeth.

The Circumference of every Circle, is understood to be divided into 360 Parts, called Degrees; and every one of these into 60 other Parts, called Minutes; or into 100 Parts, called Centelms! But the Reason of this Division may be demanded, Wherefore into 360, and into no other Number, did the first Artists divide every Circumference? I Answer, That only Magnitude being to be divided into certain parts, the fame ought to be divided into the least and belt, for dividing as in equal parts: But so it was, that no Number under 360 could be had, as being divisible into more equal parts; and likewise being a Number not very troublesome to the Memory. Therefore not without Cause or Reason they made choice of that Number before any greater or leffer.

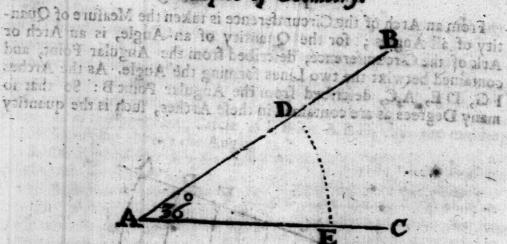
From an Arch of the Circumference is taken the Measure of Quantity of all Angles; for the Quantity of an Angle, is an Arch or Ark of the Circumference, described from the Angular Point, and contained betwixt the two Lines forming the Angle. As the Arches FG, DE, AC, described from the Angular Point B: So that fo many Degrees as are contained in these Arches, such is the quantity



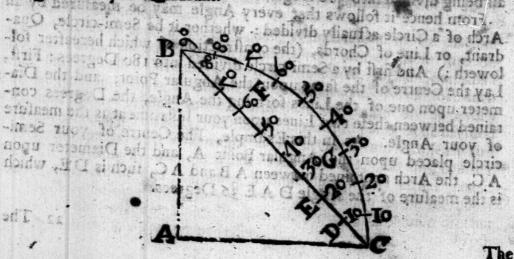
of the Angle A.B.C. I fay all these Arches being equal; not according to quantity of entention: for certain it is that I G will be leffer than A C; but heav they are equal according to the number of Parts, for there are more Parts in the Arch AC than in FG, although the quantity of the one be greater than the quantity of the other; became all Gircles described from the same Centre are equal, all being divided into 360 Degrees.

From hence it follows that every Angle may be measured by an

Arch of a Circle actually divided; whether it be Semi-circle, Quadrant, or Line of Chords, (the construction of which hereafter followeth;) And first by a Semi-circle divided into 180 Degrees: First, Lay the Centre of the same upon the Angular Point, and the Diameter upon one of the Lines forming the Angle, the Degrees contained between these two Lines upon your Instrument is the measure of your Angle. As in this Example, The Centre of your Semicircle placed upon the Angular Point A, and the Diameter upon A.C., the Arch contained between A B and A.C., fuch is D.E., which is the measure of the Angle D A E 36 Degrees.



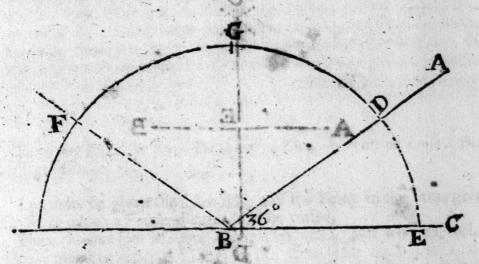
Line of Chords, which is described upon a Ruler; which Line is virtually the Arch of a Circle; The Projection whereof is as followeth: Let there be a Quadrant, or fourth part of a Circle, as BAC, divided into 90 Degrees; First, Into three parts, each containing 30 Degrees, by taking the Semi-diameter, as AB, with your Compasses; place one foot in C, and with the same wideness set the other foot in F; set again the one foot of your Compasses in B, (the Compasses not being altered) and with the other take the extent BG: So your Quadrant shall be divided into three equal parts, viz. GG 30 Degrees, CF 60, and the rest unto B 90 degrees: Every one of these being again subdivided into three equal parts; so shall you have the Quadrant divided into three equal parts; so shall you have the Quadrant divided into shree equal parts; so shall you have the Quadrant divided into shree equal parts according to the largeness of your Quadrant.



The Quadrant being performed and truly divided, you shall draw a Line from B to C, which shall be the Chord of 90 degrees; again you shall place the one foot of your Compasses at C, and extend the other to 10 degrees; the same extention you shall lay off from C to D, upon the Line of Chords, still keeping the one foot of your Compasses at C; again extend your Compasses to 20 degrees, and lay them off from C to E: and so accordingly to all the rest, till you have finished the division of your Line: Which being performed, shall serve you to measure the quantity of all Right-lined Angles, as well as by any Circular Arch; being more portable, and more ready for use, than any Circular Instrument, as Semi-circle, Quadrant, &c. as by the following practice is evident.

### The Use of the Line of Chords.

23. Let there be an Angle, as ABC, whose quantity is desired: The same is performed by a Line of Chords; if you place the one foot of your Compasses at the end of your Line, and the other upon 60 degrees; then the Compasses remaining at the same wideness, place the one foot at B, and draw an Arch as DE; whose wideness you shall take by your Compasses, and apply the same to your Scale upon the Line of Chords, you shall have the quantity of the Angle 36 Degrees.



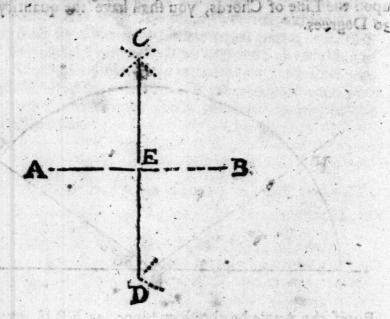
But if the Angle be obtuse or blunt, as FBC, extend the Compasses upon your Scale to 60 Degrees, drawing an Arch from the Angular Point; then first take off 90 degrees from your Line of Chords,

Chords, and place the fame from E to G, the remainder being taken from G to F, the distance whereof is 34 degrees; which two Arches being added together, shall give the quantity of the Angle FBC. reckoned 144 Degrees. And thus much for finding the quantity of all Right-lined Angles, by the Line of Chords upon your Scale.

#### CHAP. XI. Geometrical Problems.

To divide a Line given into two equal Parts at Right Angles.

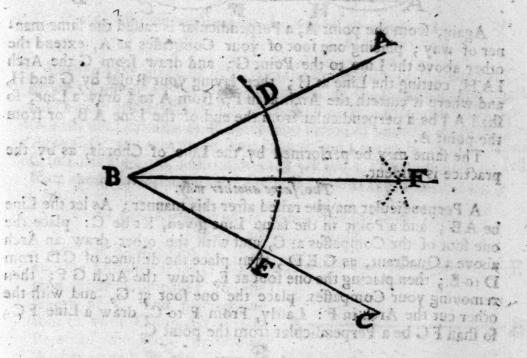
ET the Line given be AB; having placed the one foot of your Compasses at A or B; extend the other at pleasure, above the half of the Line by estimation, and draw two Arches, the one above the Line, and the other beneath; then keeping the Compasses at the fame wideness, place the one foot at the other end of the Line, cutting the former Arches in C and D with the other foot: lay a Ruler at the points C and D; and where the fame doth out the Line A B. as in E, fo thall the Line AB be cut into two equal halves at E. which was required; and the Lines CE and ED, shall be both perpendicular to the Line A B, by the 19th Definition of this.



go Dogrees.

An Angle being given, to divide the fame into two belves.

Let the Angle be ABC, to be divided into two equal halves: Place the one foot of your Compasses at B, and extend the other at your pleasure to D and E; describe two Arches cutting each other in the point F: So shall you divide the Angle ABC into two equal halves, if you draw a Line from B to F, with two Angles ABF, and FBC, as equal to the whole Angle ABC, being divided into two halves.



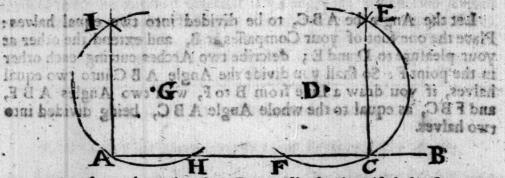
From any Point, or from the end of a Line, to erect or raise a Perpendicular.

Let there be given the Line AB, and the Point in the same given

C, from which a Perpendicular is to be raised.

Place the one foot of your Gompasses at C, and with the other take at pleasure above the Line, as D; then from the point D, describe the Arch of a Circle, as ECF, cutting the Line AB in F; then lay your Ruler at F and D, and where it cutteth the Arch as

in E, draw a Line from C to E, which shall be Perpendicular to AB, from the point C.



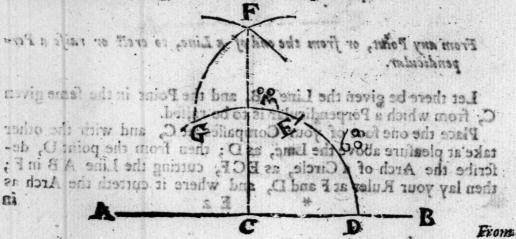
Again, from the point A, a Perpendicular is raised the same manner of way; placing one foot of your Compasses at A, extend the other above the Line to the Point G; and draw from G the Arch IAH, cutting the Line at H; then laying your Ruler by G and H, and where it cutteth the Arch as in I; from A to I draw a Line, so shall A I be a perpendicular from the end of the Line A B, or from the point A.

The fame may be performed by the Line of Chords, as by the

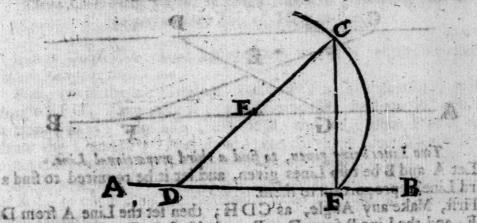
practice is evident.

The same another way.

A Perpendicular may be raised after this manner; As let the Line be AB; and a Point in the same Line given, let be C: place the one foot of the Compasses at C, and with the other draw an Archabove a Quadrant, as GED; then place the distance of CD from D to E; then placing the one foot at E, draw the Arch GF; then removing your Compasses, place the one foot at G, and with the other cut the Arch in F: Lastly, From F to C, draw a Line FC; so shall FC be a Perpendicular from the point C.



From a Point without a Line, to let fall a Perpendicular to a Line given.



Let the Line given be AB, and the Point without the same at C: Draw a Line to AB at Oblique Angles, as CD; which you shall cut (by the first Problem) in two halves at E; then place the one foot of your Compasses at E, extend the other unto C, drawing the Arch CF: and where the same cutreth the Line AB, as in F, from C to F draw a Line, as CF; so shall CF be a Perpendicular let salls from the Point C, upon the Line AB, as was required.

A Line being given, to draw a Parallel to the same,

Let the Line given be AB, and the Distance from C: Extend your Compasses to the length of C, and placing one foot of your Compasses in any Point of the Line, draw two Arches; and by the Compass of these Arches, draw a Line as DE; which shall be parallel to AB required; as CE.

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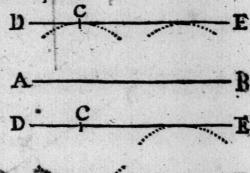
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The same another way.

Let the Line given be AB, and the Point at C: From the point C, draw a Line at pleasure unto AB, which shall touch in F, which you shall cut (by the first Problem) into two halves at E, take then a Point betwirt F and A at pleasure, which is here G: Draw then a Right-lane from the Point G, through E, and set the Distance DE, equals

equal to the Line EG: Draw then a Line through the Points CD; fo that the same Line be parallel to the Line A B.

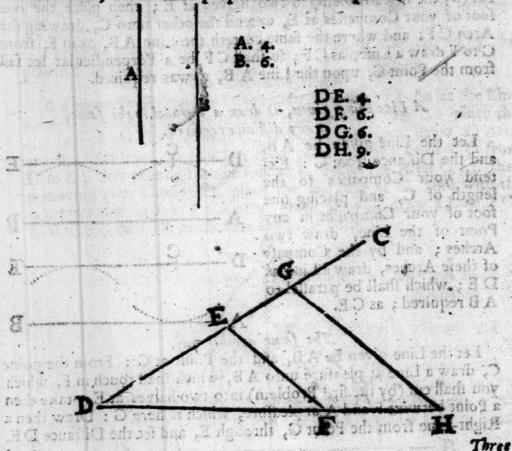


Two Lines being given, to find a third proportional Line.

Let A and B be two Lines given, and let it be required to find a

third Line in proportion to them.

First, Make any Angle, as CDH; then set the Line A from D to E, and the Line B from D to F, and also from D to G; then draw EF: that done, by the Point G draw a parallel to EF, as GH: So shall DH, be the third proportional Line required.

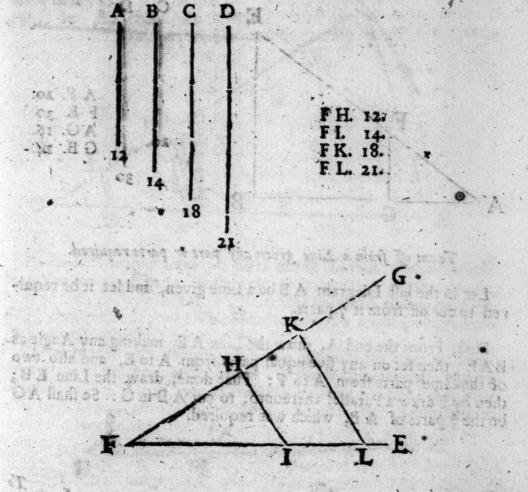


Three Lines being given, to find a fourth in propostion, that it to perform the Rule of Three in Lines.

Let A B and C be three Lines given, and it is required to find a

fourth proportional Line.

First, (as in the last Problem) make any Angle at pleasure, as the Angle EFG; Then take with your Compasses the Line A, and set it from F to H; take also the Line B, and set it from F to I, and draw the Line H !: That done, take the third Line C, and set it upon the Line FG, wix (always upon the same Line where the first Line A was placed) from F to K; then by K draw a Parallel to H I, as K L, to cut F E in L: So shall F L be the fourth Proportional Line required.

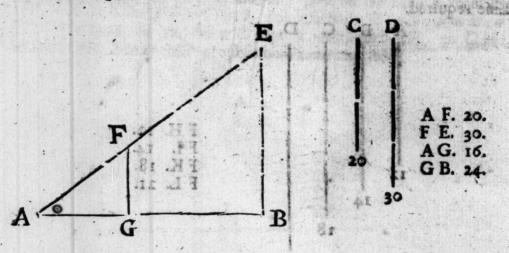


To divide a Line given into two parts, in proportion one to the other, according to two Lines given.

Let A B be a Line given, to be divided into two such parts, that the lesser may be in proportion to the greater: As the Line C, to the Line D.

folio dake with vose Comos

From the end A draw the Line AE, making the Angle BAE: then fet the Line C from A to F, and the Line D from F to E, and draw the Line EB: Laftly, By the Point F draw a Parallel to EB, as FG, to cut AB in G: So shall AB be divided in G, as C to D, which was required.



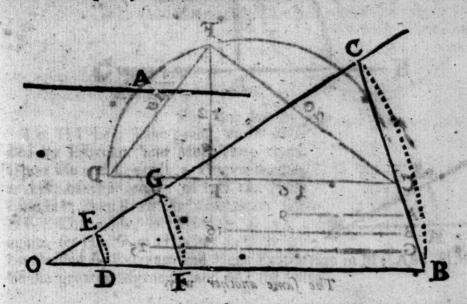
To cut off from a Line given any part or parts required.

Let in the last Diagram AB be a Line given, and let it be requi-

BAE; then set on any five equal parts from A to E, and also two of the same parts from A to F: That done, draw the Line E B; then by F draw a Parallel thereunto, to cut A B in G: So shall AG be the \(\frac{2}{3}\) parts of A B, which was required.

To divide a Line in fuch fort, as another Line is before divided.

This Problem differeth not much from the two last Problems. Draw a Right Line at pleasure, as the Line O B, which Line you shall divide into 100 equal parts as exactly as you can; then extend your Compasses to the Distance O B, and describe an Arch; in which Arch you are to include the desired Line A; then draw the Line OC, and you have the Angle C O B: which we shall hold for a ground-Rule; because the Legs O B and O C, contain each of them 100 or 1000 parts, which is in the Line A.



Example. I would have 35 parts of the Line A, (whose whole length making 100 parts, as the Line O B doth): I number on the Line O B 35 parts from O to F; with this distance I draw the Arch F G; then is the nearest Distance from F to G a Right Line, which is the 35 parts of the Line A.

Likewise is it were desired to have 15 parts of the Line A: then draw from O the Arch E D; which Distance is the desired 15 parts of the Line A; as the Learned Adriani Meti doth teach. And also how to find the Parts of a longer Line, than the Line of Measure it self is; it is done after the same manner; and is of great use to a Gunner.

V/e. This may be of great use, if the Gunner be to find the first Pound Ball in a strange place, and the Weight unequal to Ours.

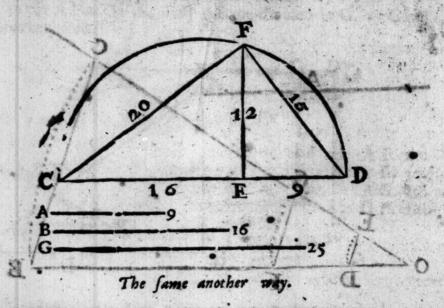
E

Retween

### Bermeen two Lines given, to find a mean propertion.

Let A and B be two Lines given, between the which it is required

Oran a Right Line at pleature, as the Lin neuroque usame bail or Join the Lines A and B fo together, that they make one Right Line as C D, being joined together in the Point E; and upon the Line CD describe the Semi-circle, viz. CFD: Then upon the Point E, where the Lines A and B being joined together meet, erect a Perpendicular to cut the Limb in E, as E F, which shall be a mean Proportion between the Lines A and B required.



Again in the fame Diagram, let the Lines A and G be given, be-

tween the which it is required to find a mean Proportion.

Take the Line G, and lay it down from C to D, and draw C D; wherenpon describe the Semi-circle CFD: Then take the Line A. and set it down from D to E; Then upon the Point E, erect a Per-pendicular to cut the Limbin F; Lastly, Draw D F, which shall be a mean Proportion between D E and D C, or between the Lines A and Grequired. And if you draw CF, it shall be a mean between B and G, that is, between C E and CD.

To divide a Line given by Extream and Mean Proportion. Let AB be a Line given to be divided by Extream and Mean Proportion. Increase A B at length to C; then upon the Point A erect

a Perpendicular as A D, of the length of AB. That done, take half A D, or A B, and fee it from A to E, then with the distance ED make the Arch DG: So shall A B be divided by Extream and Mean Proportion in G, and A G is the greater Segment, and G B the leffer.



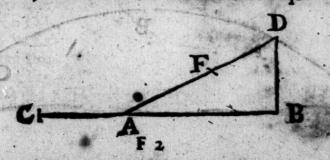
while Sodar A sient to The fame another way. Let HI be a Line given, to be divi-ded by Extream and Mean Proportion. Upon the end I, erect a Perpendicular, as IK, of the length of half the given Line HI; then draw the fubrendant fide HK: That done, fer KI from K to L: again, fet HL from H to M; fo fhall HI



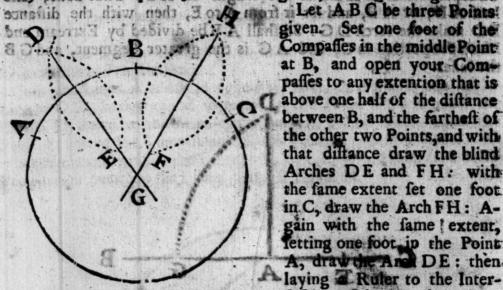
be divided by Extream and Mean Proportion in M: And HM shall be the greater Segment, and M I the leffer.

The greater Segment of a Line divided by Extream and Mean Propertion, to find the whole Line.

Let A B be the greater Segment given, and the whole Line is required. Increase BA to C; then upon the end B erect a Perpendicular of half the length of A B, as BD; and draw the subtendant fide AD; from which subtract DB, rests AF: That done, fet AF from A to C; fo shall C B be the whole Line required.



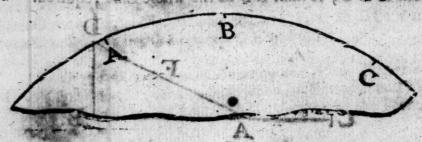
To deferibe a Circle upon any three Paints given, not being in a Right Line



given. Set one foot of the Compasses in the middle Point at B, and open your Compasses to any extention that is Q above one half of the distance between B, and the farthest of the other two Points, and with that distance draw the blind Arches DE and FH: with the fame extent fet one foot in C, draw the Arch FH: Again with the same extent, letting one foot in the Point A, drawthe And DE: then A laying Ruler to the Inter-

the Lines DG and HG; which will cross each other in the Point Gand there is the Center of the Circle inquired. Where ferring one foot of your Compasses, and extending the other to any of the the three Points; you describe the Arch of a Circle, which shall pass through the three Points given, and give the whole Circumference required: which having, you may find the Diameter by the 12th Definition of Chap, 10. of this Book.

Observation. Here it is to be observed, That if any Town, Form or Place be Befieged or Blocked up by an Enemy, and the Enemy fhooting continually, there are divers Segments or Pieces of their Ball found in the Place; and it is defired to know what Ordnance they do Batter with. The Gunner shall take the Segment or piece of Ball, and lay it on a piece of Paper, and fet there down by the Circumference three Pricks or Points, as ABC in the Figure following, and thereby, and by the preceeding Problem, shall find the Diameter, Center, and Circumference of the Ball, whereby you may know the weight of that Ball; as is described in page 54.

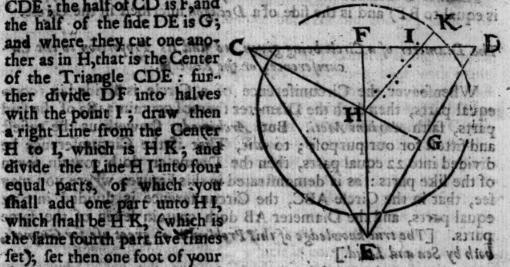


Horo

How to Reduce a Right Line into the Circumference of a Circle. The Line given being AB, to be reduced into a Circumference.

The which Line A B, you shall first divide into three equal parts. and of these three Parts you shal Imake an Equilateral Triangle, as

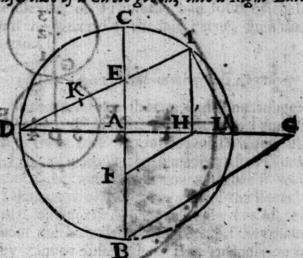
CDE; the half of CD is F, and the half of the fide DE is G; and where they cut one another as in H, that is the Center of the Triangle CDE: further divide DF into halves with the point I; draw then a right Line from the Center H to I, which is H K; and , and et ; logang reo to divide the Line H l'into four and a to a to la posse shall add one part unto HI and add and fet); fet then one foot of your Compasses in the point H, and



the other in the point K; and draw with the same distance a round Circle, whose Circumference shall be equal to the Line given, viz. the Line A B which was required.

How to reduce the Circumference of a Circle given, into a Right Line.

Let the Circle given be ABCD. Divide the fame Circle in 4 equal. parts with the 2 Diameters BC, and DL, which cutteth one another at Right Angles in A; divide A C in the middle in E, thro' the which draw DI, and from I draw aperpendicular upon D L, and divide AB in Extream and Mean Proportion at F, (by Pro-



blem 12 of this) draw FH, and parallel to the same from B draw BG.

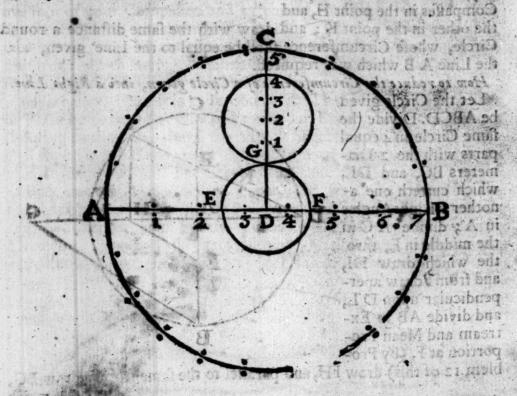
which cutteth the prolonged Line DL in G; fo is AG a fourth part of the Circumference BDCL.

The Mean Proportion betwixt D L and A G, the fourth part of the Circumference, giveth the fide of a Square equal to the Circle.

From DE subtract the half of AC, there remainerh DK, (which is equal to BF) and is the side of a Decagon inscribed in the Circle.

The Diameter of a Circle being given, to find its Proportion to the Circumference, or the Reverfe.

Whenfoever the Circumference of a Circle is divided in 10000 equal parts, then doth the Diameter thereof contain 3183 of the faid parts, faith Adriani Meti. But Archimedes theweth us the easiest and fittest for our purpose; to wit, That if the Circumference be divided into 22 equal parts, then the Diameter doth contain seven of the like parts: as is demonstrated in this Figure, where you may see, that in the Circle ABC, the Circumference is divided into 22 equal parts, and the Diameter AB doth contain seven of the same parts. [The true knowledge of this Problem is of great wie for Gunners, both by Sea and Land.]



CHAP. XII. How to know the Proportion of a crue Fortified Iron Gun.

By the Demonstration of the last Problem, you have the propertion of a true Fortified Iron Peece; for a true Fortified Peece of Ordnance being of Iron, hath I to Diameters of the Bore about the Breech, measuring at the Touch-hole betwint the Rings; which to describe is thus.

In the Diagram of the 17th Problem, the Diameter being divided into 7 equal parts, as is the Diameter AB; then take with your Companies one of the same parts, and set one soot in the Center, and with the other draw the Circle EGF, then shall the Line EF be the Diameter of the Bore of that Peece of Ordnance, and the Circle ACB, the Circumference of the Breech of the same Peece at the Touch hole; where it followesh that one 22 part of a well-proportioned Peece of Ordnance made of Iron, measured about the Breech, is half the Diameter of the Bore of the same Peece; the which is 11 Diameters of the Bore, as aforesaid: And therefore one side Metal, or the thickness of Metal at the Touch-hole is 12 Diameter of the Bore, as appeareth from G to C, which is compleatly demonstrated by the said Diagram of the 17th Problem: Also by the Neck, near the Muzzle of the Gun, are seven Diameters of the Bore about; which is near 1 parts of the Diameter in Metal.

If you should take the Diameter of the Breech of this Peece seven times to be the length of the Peede, and allow three of those parts betwirt the Breech and the Meeks, or Trunions, and sour of these parts betwirt the Meeks and the Muzzle of the said Peece, then that

Peece hath her true proportion.

The Reason why one Gun must have more, and another less Popder.

Tho' there are many Gun's that are some shorter, and some longer, yet they ought not to be thinner of Metal; for if they be thinner, then they are not able to have their true proportion of Powder, either for Proof or Action: Likewise know that true Fortified Guns, and true Bored Brass Ordnance, be their Denomination what it will, ought to have at least o Diameters of the Bore about the Breech, measuring at the Touch-hole, and at the Meeks 7 Diameters of the Bore, and 5 Diameters about the Muzzle at the Meck: if they have less than is above-laid, they cannot suffer their true proportion of Powder, either for Proof or Action: But this you must help, by what shall be fully described in its proper place.

ny Gungers, wet I find it by my Observation, better to destond the tree Wind or a Pacer, as in the figure fallowing.

CHAP. XIII. How to extract the Wind from the Bore of a Prece

Line you are to divide into equal halves, as EB and ED; then you have the Centre E, by which you draw the Circle ADCB: Which being done, with your Compasses at the same extent draw an Arch from the Point D, extended to AEC; then draw the Chord-Line ALC; keeping still your Compasses at the same extent, measure from A to D, then to C, and so to O: then extend your Compasses from D to O, and draw the Arch O N, which cutteth the Diameter in F: then divide the Line F B into three equal parts, and take one of these parts and place under the Centre E in H, extend your Compasses from H to D, and draw the Circle, whose Diameter is DG, and is a Ball sitting for such a Peece, where you are to observe that GB is the Height of the Wind of the Peece.

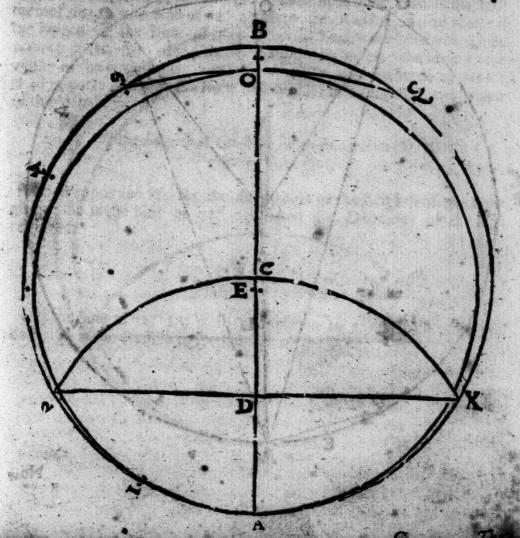
is nell the Diameter of the love Selie time Person the which is to Diameters of the Bone of one life in and of the thickness of teles at the FB hands is Bore, as appeared from the Carlo control Diameter of the compleant demonstrated by rbetaid I gray the Fergent Andrews of which which I have to be a made to a street which which is a street of the street of th withe Meck, near the file the that the the Breech of she matte of treatment and allow three of the parts between the Brute is and the Medica or Truniques, and four parts ser wife the Meeks and the Augzle of the faid Feece, heat that he here to the tree population. mer fome thorceria. te of the Bone Lead Loss thole, and at the Meeks of Differens the Muzzle it the true proportion of ens ven munt help. br

observ. And the this former Demonstration be approved by many Gunners, yet I find it by my Observation, better to demonstrate the Wind of a Peece, as in the figure following.

First,

A Light to the Art of Gunnery.

First, draw the Diameter BA, which being divided into two equal parts at C, extend your Compasses from C to A or B, and draw the Circle 1. 2. 3. 4. 5, which here represents the Bore of the Peece: Keeping your Compasses at the same extention, place one foot in A, and draw the Arch 2, C, X; then drawing the Chord-Line 2, K, it divides the Semi-diameter of the Bore into two equal parts; then you are to extend your Compasses to the distance AD, or DC: So fixing one foot of your Compasses in A, you are to measure five of these Dimensions about the Circle, as you see them described, 1. 2. 3. 4.5; then you must extend your Compasses from A to 5, and draw the Arch 5, Q, whereof A is the Centre; then you must divide the distance OB into two equal parts, and take one of these parts, and fet it upon the Diameter below C in the point E; then you are to extend your Compasses from E to A, keeping one foot in E, draw the Circle, whose Diameter is AEO: and is a Ball fit for such a Peece as hath for Diameter ACB.



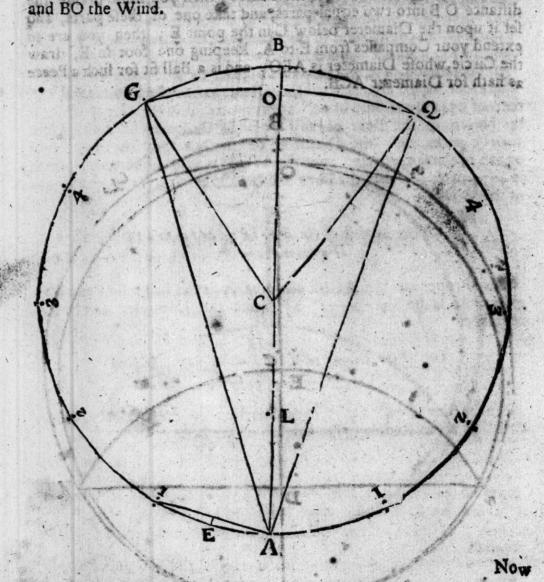
# on to a sould and the fame by Calculation of garage H : soos

A Light to the wint of Course

In the following Diagram AB, the height of the Bore of a Peece

being given, to find the Diameter of the Ball AO.

First, Take the Semi-Radius AL, and set it off in the Circumserence from A towards B five times, as you see here marked with 1.2.3.4.G; or 1.2.3.4.Q: then extend your Compasses from A to G, and draw the Arch GOQ, so is AO the Diameter of the Ball, and BO the Wind.



Now to find this by Calculation, First, consider that AG or AQ is equal to AO, and A 1 equal to AL; then AL being the Semi-Radius 50000, is equal to the Chord A 1, withal considering that the Chord of an Arch is equal to double the Sine of half that Arch; Now then 25000 the half of AL is the Sine AE, which in the Table of Natural Sines, giveth 14° 29', for the Arch AE, the double where-of giveth 28° 58', for the quantity of the Arch AI, which being quintupled, or multiplied by 5, giveth 144° 50' for the Arch AG or AQ, so that the Arch GBQ is 70° 20': The Angle ACG may be measured with a Line of Chords from the Plain Scale to be 144° 50'. The Chord whereof AG, is equal to twice the Sine of 72° 25', viz. 95327; the double whereof is 190054, which is equal to the heighth of the Ball, in comparison to the Bore AB, 200000, twice the Radius, or the whole Diameter.

In proportion, as Double is to Double, so is Single to Single: Therefore as 190654 is unto the Diameter 200000, so is the half thereof 95327, the Sine of 72° 25' unto the Radius: I say then, if the height of the Bore of any Peece of Ordnance be divided into 100000 parts, then the Diameter of the Ball is for the same Peece 95327 of the same parts; and the Wind is the Difference, which is 4673 parts, so that the Bore will be about 213 times the height

of the Wind.

Diameter of the Ball.

The Proportion is: As the Radius is to the heighth of the Bore given: So is the Sine of 72° 25', unto the Diameter of the Ball-required.

Or, if the Diameter of the Ball be given, to find the Bore: Say then,

As the Sine of 72° 25' is in proportion to the Diameter of the Ball: So is the Radius to the heighth of the Bore.

Laniwer, The Diameter of the Ball that will fit flich a reece, and the rinches, and the parts of an lark. And to of others.

Another

Example. I have an Iron Ball whose Diameter is four Inches, and weigherh 9 th English Weight, and I desire to know what heighth the Bore of the Peece will be, which this Ball shall fit, the Wind duly extracted. the so much some of his bear work.

Sine of			
72°25'		hes	Radius
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			400000

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95327	the feet of years in
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915930	ropace parts, the
213934	or ago of the factor
UN /544	rall singular dire

I Answer, The Heighth of the Bore of such a Peece of Ordnance is 4 Inches and ; part fere.

Example. 2. I have a Gun whose Bore is 6 Inches Diameter, and I would know what Diameter must the Ball have, that will fit such a Peece, the Wind duly extracted.

B 11				Sine of
Radius		Inche	S	72° 25'
1500000	).	6		95327
*				6
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	
			•	171962

I Answer, The Diameter of the Ball that will fit fuch a Peece. must be 5 Inches, and 12 parts of an Inch. And so of others.

Another

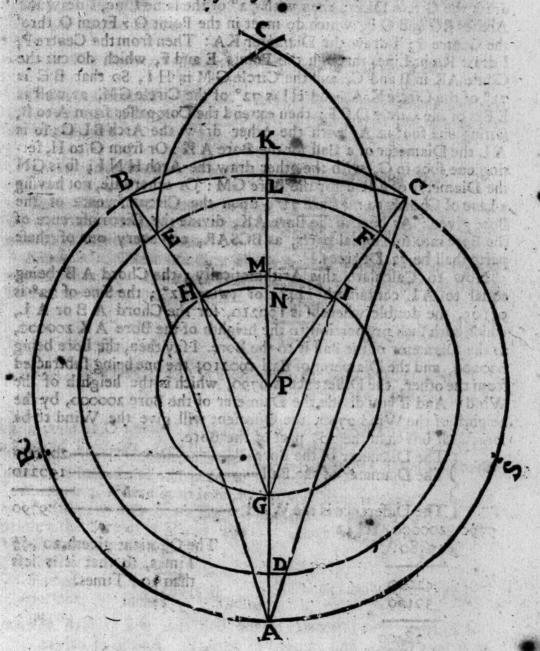
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Another way to Extract the Wind of a Gun, as well Geometrically as by Calculation.



The

The Height of the Bore of any Peece of Ordnance being given. as the Bore AK or GM (in the preceding Diagram) to find the Diameter of the Ball : First, with 60° of the Line of Chords, I draw the Circle DEF; then with 72° of the same Line, I draw the Arches BO and O F, which do meet in the Point O: From O thro' the Centre P; I draw the Diameter KA: Then from the Centre P. I draw Right Lines through the Points E and F, which do cut the Circle AK in B and C, and the Circle G M in H I, So that B'C is 72° of the Circle K A, and HI is 72° of the Circle GM, as well as EF is of the Circle DEF: then extend the Compasses from A to B. fetting one foot in A, with the other draw the Arch BL C: fo is A L the Diameter of a Ball for the Bore A K : Or from G to H. fetting one foot in G, with the other draw the Arch HNI; fo is GN the Diameter of a Ball for the Bore GM: Or otherwise, not having a Line of Chords to measure 72°, upon the Circumference of the Bore given: As here in the Bore AK, divide the Circumference of the Bore into five equal parts, as BCSAR, and every one of these parts shall be 72 Degrees.

Now to Calculate this Arithmetically; the Chord A B being equal to AL containeth 144°, or twice 72°; the Sine of 72° is 95105, the double whereof is 190210, for the Chord A B or A L, which hath such proportion to the heighth of the Bore A K 200000, as the Diameter of the Ball is to the Bore. I say then, the bore being 200000, and the Diameter of Ball 190210, the one being subtracted from the other, the Difference is 9790, which is the heighth of the Wind: And if you divide the Diameter of the Bore 200000, by the heighth of the Wind 9790, the Quotient will give the Wind to be

fomewhat less than the 20; part of the Bore.

	The Diameter of the Bore- The Diameter of the Ball-	200000
	The Difference is the Wind	9790
9790	2000000 (20142	The Quotient giveth 20, 43 Times, fo that it is less
	42000 39160	than 20 Times.
	28400 19580	
241	8820	As

# A Light to the Art of Gunnery. 41

As the Chord of 144, viz. 190210, is in Proportion to the Diameter 200000; So is the half thereof the Sine of 72°, viz. 95105, unto the Radius 10000. o le flat s le resement! sa

## The Diameter of a Bore being given, to find the Ball.

Remaind to 3 Kenticky McKets to remaind as

Hence it followeth, That as the Radius is in Proportion to the Diameter of the Bore; So is the Sine of 729 oor to the Diameter. of the Ball on williams the stood essential socsessi (

#### Or if the Diameter of a Ball were given, to find the Bore. a sall of 6 15 th Boots weight, and near the

charter of lay, Touch His Scooning and other Linglish.

Then should the Proportion be, as the Sine of 72° 00', viz. octor is unto the Diameter of the Ball : So is the Radius 100000 unto the Heighth of the Borer A . the was took to use vasy asset

Example 1. There is a Gun whose Bore is 7 Inches Diameter, 1 would know what Diameter must the Ball have, that will fit fuch a Peece, the Wind duly extracted.

Radius	Inches	Sine of
1F00000	7	95105
· Vice co		<u> </u>
horas J <b>e</b> linas II		6_65735

I Answer, The Diameter of the Ball that will fit such a Peece,

must be 6 Inches and 165 parts of an Inch.

Example 2. There is an Iron Ball whose Diameter is 6 Inches, and weigheth 30 th 6 Ounces, English Weight: I defire to know what heighth the Bore of a Peece will be, which this Ball shall fit, the Wind duly extracted.

Sine of 72°00′ 95105 :	Inches	Radius 100000	95105 600000 613
		6	293700
	A .	600000	285315
			8315

I Answer, The Heighth of the Bore of such a Peece of Ordnance will be 6 Inches and 18 parts of an Inch. And so of others.

Observation. The Diameter of the Peece A C B is 4; Inches very

near, which is the Diameter of a Ball of 91 th Scots weight.

And the Diameter of the Ball which is A E O 4 Inches, is 8 the Scots weight. Now the aforesaid Diameter A CB of 4; Inches, is the Diameter of a Ball of 10; the English weight.

And likewise the Diameter AEO, of 4 Inches, is the Diameter

of a Ball of o th English weight and and a grade and to required

So that the Difference between Scots and English weight is as 8 is

to 9; that is to fay, That 8 th Scots maketh 9 th English.

For the first Demonstration, the Diameter DB is 3; Inches, which is near the Diameter of a Ball of 6; 7 th Scots weight, and near the Diameter of a Ball of 7† the English weight. And the Diameter DHG is 3; Inches, which is the Diameter of a Ball of 5 th 6; Ounces very near of Scots weight. And the Diameter of 3; Inches, is near 6 the English weight, not following the Tables of Mr. Smith, nor any other that I have seen as yet set forth; As I intend to Bemonstrate in its due place.

ZICHEJE

Objection.

Authornibe Cart 1986 a

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Objection. This Geometrical Description may be said by some, That they know better; for Mr. Henham hath deciphered the Bore

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Your Peece,	STATE OF THE STATE	是一种自己的企业。然后这一位	TEN MARKET CO. T. C.
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of the Pector and the Balkin another manner Therefore I will Demonstrate the Way that Mr. Hexben takes to extract the Wind

of a Peece, and thereby to find the true Ball.

Example. Take just the Diameter of the Bore of your Peece, which you divide into two equal parts, and draw the Circle A B E; then the Compasses at the same station, you place one foot in A, and another in B, and draw the Cross Arches A C B: From C draw a Line through the Center D to E, and then draw the Line A E: then place one foot of your Compasses in E, and draw the Arch AB: then place one foot of your Compasses in the Center D, and extend the other to the Arch F, so draw the Circle F G: which he saith is the way to find a true Ball. I shall answer this Objection.

Here you have the Demonstration of Mr. Henry Hexham, where you see a gross mistake: for as he supposeth FG, or EK to be the true Ball: And I find IE is the true Ball for that Peece, and have wrought this as you have it in Folio 22. Wherefore I leave the Ingenious Gunner to judge, which of these Experiments are the best and truest.

CHAP. XV. The Demonstrations of the Cannon-Bore, and of all other Perces of Ordnance to the Rabinet, by Letters: As also the Geometrical Extracting or Deducing of the Wind or Vent of those Peeces, whereby you may know the exact Diameter of the true Balt fitting those Peeces.

weight weight	ut of	Ball.	
WA is the Bore of the Cannon-Royal; the distance be- twist A and B, is the true Vent or Wind, that ought	tb\	th	
WG is the bore of the Cannon-Ordinary; the Distance	64	72	NOTH NAMED IN
CD is the Wind; and D the heighth of the Ball	48	54	
F the Diameter of the Ball- WG is the bore of the Demi-Cannon Royal; GH the	36	403	
Wind; H the Diameter of the Ball WI is the bore of the Demi-Cannon Ordinary; IK the	30	334	
Wind; K the Diameter of the Ball	24	27	November 1
wL is the bore of the Culvering, or Demi-French Can- non; LM the Wind; and M the Diameter of the bore WN is the bore of the Quarter Cannon Ordinary; NO	18	204	2 12 12 12 12 14 15 15 15 15 15 15 15 15 15 15 15 15 15
the Wind; and Othe Diameter of the Ball	12	131	STATE OF STREET
WP is the bore of the Demi-Culvering; PQ the Wind; and Q the Diameter of the Ball	8	9	E/STROPORONE
WR is the bore of a large Saker, RS the Wind; and S the Diameter of the Ball	6	63	Contractor Street
		WI	100

### A Light to the Art of Gunnery.

	WT is the bore of a Saker , VT the Wind ; and Valie 4 15 10 to	
	height of the Ball - quilt to atal no Hall to adjusting	
	WK is the bore of a Minion; XY the Wind; and Y the	
	height of the Ball	
	WZ is the bore of a Faucon; ZX the Wind; and X the	
1	heighth of the Ball 2 21	
	W= is the bore of a Rabinet; = 0 the Wind; and 0	
	the heighth of the Ball	

Note: In the Column next your left hand you have the Scots Weight of the Ball; and in the Column next your right hand you have the English Weight of the same.

The Ancient and Later Rules given for Gunners, to give Powder to great Ordnance of all forts, that are drawn on Carriages.

11

In Ancient times it is faid, That the great Chamber'd Guns, that that Stone-Ball, had for their ordinary one pound of Powder to three pound and half, or at most four pound weight of their Ball. This was certainly the fiest invention of Guns; and in regard they could not cast Iron, they made their Guns, as Coopers do Cask, with Staves of Iron and Hoops. Likewise that those Guns that shot Iron-Ball, must have to every three pound of Iron-Ball, one pound of Powder; and this they held for a General Rule, not examining the Fortification of their Peeces. Now at this time Powder was made of all the three Ingredients equal, and therefore could not be firing. But afterward it was found, that all fort of Field-Ordnance, not being Chamber'd, but true Bored, should be loaded in this manner, (to wit) The Gunner shall take the Diameter of the Ball, or the Diameter of the Bore of the Peece with a pair of Compalles; and this Diameter three times the Gunner must set off upon his Gun from the Touch-hole toward the Muzzle; which distance being fill'd with Powder, then, faid they, One pound of Powder was allowed to two pound of Ball : this was the Rule of the Primitive Gunners. But now in our time Powder is to variously made, and the difference is such, that it is hardly possible to the best Judgment, to give a true Rule what Powder is fufficient either for Proof or Action; and therefore the Gunner ought to try his Powder before he load his Peece; for it is beyond all question, that if the Powder be decayed, there must be more of it used than of fresh dry Powder : But if Powder be of Her Majesties Tower-Proof, as I am informed, that then the Gunner need not take near fo much Powder to shoot among a party of Men,

H 2

DOE

not being at a great distance, as the Peece would crave to battera

Fortification, or Wall, or Gate, or Ship. \_\_\_\_ is a set to related

But because the young Gunner, that is not yet experimented in his Practice, may be taught how he shall load all manner of Guns : and that it is to be understood, that ordinarily those that will be called Gunners, though not known in the Art, use to load their Guns with half the weight of the Ball of Powder; this they hold for a general Rule to all Guns, which Rule is not to be flighted on some occasions, with true-Bored, true-Fortified Ordnance, (yet it may be faid, they have this by Tradition) to hold this Rule, without adding to reinforc'd Ordnance, or deducting from those that are leffened of Metal; fo that by this, they not having any other Rule, discover their own nakedness or emptiness of Art ; for I am perfwaded that no experienced Gunner, but will hold that the Gunner ought to fearch, try, and find the Nature and Fortification of a Gun or Guns, before he do hold himself obliged to give a Gun Powder, and thereby to prove a true Charge of Powder for the fame. Got Stone-Rail, had that their ordinary one pound of Powder to

# CHAP. XV. The Reasons why I give Guns Powder according to their

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These first Rules were derived from the weight of Ball; but since the Rules were made for the weight of the Peece: for they held generally that sour ounces of Powder was sufficient for the Gunner to give a brass Gun, to every hundred weight for Service; and three ounces to every hundred weight of Iron Guns. Neither this nor the other being right, for I have seen Trumpet-bored Iron Guns of 1200 weight, that could not have half the allowed Powder that either of these Rules did allow of. And likewise I read the Cause of the Death of King James the Second of Scotland, was by the breaking of a great Gun at the Siege of Resburgh.

For these and the following Reasons, I do not hold with that common received Rule, than which many Gunners know no better, but to give Ordnance Powder by the weight of the Gun. For if there be a Peece of Ordnance of Iron weighing 1600 pound weight, likewise there is another Peece of the same Bore, and of the same weight:

Now by the Rule of weight it must have the like Powder.

But will you consider, for your Instruction, this Peece is longer, and having no more Metal in her than the other, of necessity she must be thinner of Metal; for what she hath of the length, she must want of her thickness, the bore being both of one denomination;

and fince the is thin it, it followeth the must not have so much Powder as the other.

Likewise if by the weight of Guns they should have their Powder, why then do not Founders, where they now make them eight foot long, make them ten foot long? for it is known to the World, that a Peece of ten foot long will shoot further than a Peece of eight foot long, but not without equal Powder: Wherefore it is to be considered, they must be both of one Fortification; and being alike in strength, the longest of the two ought to shoot farthest, because more of her Powder is spent in Fire before she deliver her Ball.

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Quest. But some may demand what I mean by Fortised Ordnance?
Answer. For their Fortisication, know that there are Ordnance of several Fortisications, as is before shown in pag. 28. where it is sufficient to understand the Fortisications of Guns, and also what Powder ought to be given to Guns according to their Fortisications. As first you see the Geometrical Demonstration of Archimede's Proportion in pag. 27. how fitly that doth give the true Proportion of all true-Bored and true Fortised Iron Ordnance.

Now to be capable of the same Proportion Arithmetically, the Proportion is, as 22 the Circumference is unto 7 the Diameter: So must 11 the number of times which the Diameter of the bore measured about her Breech be, to a number sought for; which by the Work I find to be 3! Diameters of the bore, which this Peece is of Diameter at the Touch-hole.

Cometh 3 and 1 which is equal to 1

Rules to find the thickness of a True Bored Gun in one side Metal, by all the Diameters.

Whilst the bore it self is one of the Diameters, that being deduced from 31, rests 21, whereby 11 is the thickness of that Peece in one side Metal; and because these be the Ordnance of Iron, by which the Ground-Rule may be and ordinarily is laid down, to give Guns their Powder of other Fortisications; for you must know that there are some lessened, as thinner Fortisied, and so cannot have the same propertion

proportion of Powder, though they shoot one and the fame Ball Likewise there are Reinforc'd, or thicker Ordnance at the charged Cyllinder, which shoot the same Ball, and must have more Powder: So you may fee that the Iron Peece is 11 Diameters of the bore about the Breech, o Diameters at the Trunions, and 7 at the Neck.

Likewise the Brass Peece is no thicker at the Charged Cylinder. than the Iron Peece is at the Trunnions, yet thoots the fame Ball, and must have the same Powder; her proportion is 9 Diameters of the bore about the Breech, 7 about the Ears, and 5 about the Neck.

Seeing you have the proportion of these true Fortified Ordnance : now it followeth of necessity that the Powder of all fuch Ordnance thould be known: And as writing at length would be redious therefore I have Calculated Tables both for Proof and Action, not denominating the Names or Weight of these Ordnance.

But thus fortified with I T Diameters of the bore about the Breech.

Miron, Ordnance shooting from one pound Ball to 48 pound.

Also the same Tables will serve for Brais Ordnance, being Fortified with 9 Diameters of the bore about the Breech, by what name foever you define them, theoring from one pound Ball to 48 pound much it the number of rights which the 1 and or o

The Weight of the Ball and Fortification of Ordnance, are true Rules to give Guns their Pewder.

Hereby it is clear, That we are not to examine the Weight of Ordnance, and thereby to give them Powder; but inspection is to be had to the Fortification of all forts of Ordnance, as also to their Weight of Ball: To find the Ball fitting a Peece, by extracting the Wind Geometrically, whereby you may have the true Diameter of the Peece, and by the Diameter you may find the Weight of the Ball, as shall be shown at large in its place, in Tables, Scale, or Height-Rule, and also Arithmetically.

But in regard there hath never any pains been taken for regula-aing the true Powder for Ordnance, I have therefore for down these Tables following for Powder, for Proof and Action of true Bored

from 11, rent 21, where it is the thirty bis of that rent in one tide stairs, and because the bear of the by a nich the

and true Fortified Ordnance.

a participant

Table for Proof-Powder, for True, Table for Action of True-Bored & Bored and True - Fortified Ordnance, either of Brass or Iron.

True-Fortified Ordnance, either of Brass or Iron.

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4	4	00	20	13	06	36	24	00	4	2	05	20	8	14	36	16	00
5	5	00	21	14	00	37	24	10	5	3	00	21	9		Land Supple		07
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16	11	08	132	21	05	48	32	00	16	7	07	32	14	03	48	21	05

In this Table you have the weight of the Ball, in the first, third, weight of Ball, in the first, third, and fifth Columns, and is marked and fifth Columns, marked with with the Letter B; and in the fe-the Letter B; and in the fecond cond, fourth, and fixth Columns, fourth, and fixth Columns, being the Powder to prove these Guns, marked with the Letter P, the which is marked with the Letter P. Powder for Action for the Guns being true-bored and Fortified, Brafs being Fortified, as before-faid, eio, and Iron 11 Diameters of the ther Brass or Iron. The probore about the Breech

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In this Table you have the portion you find in the Copper-Print, No 1. and No 2.

A Scale you have for Powder, both for English and Scots true-Bored, true-Fortified Ordnance, Brais or Iron, for Service, on the Quadrant Rule

Having shown the proportion of these Ordnance, and their due Powder, both for proof and Action, it is now necessary to know the proportion of their Ladles, Rammers, and Sponge-heads.

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First, Know that all true-Fortissed Ordnance have not one proportion of Powder, as you may see by the foregoing Tables; neither must their Ladles be of equal length or breadth according to their bore

To make this the more clear, know that the Powder doth not lie in one proportioned length in every true-bored, true Fortified Peece; For those that shoot from one pound Ball to eight pound, the Powder lieth three Diameters of the Ball in length in a Cartradge, made on a Mold of the Diameter of the Ball.

The names of these Ordnance are these; a Base, a Fauconer, a

Faucon, a Minion, a Saker, and a Demi-Culvering.

Likewise for these Ordnance that shoot from eight pound Ball to eighteen pound, the Powder lieth about two Diameters and a half long in a Cartradge, made on the Diameter of the Ball; their names are Demi-Culvering, Quarter-Cannon, Culvering, or French Demi-Cannon.

And for these true-Bored, true-Fortisted Ordnance, that shoot from 18 % ball to 48 %, the Powder lieth two Diameters and a quarter long in a Cartradge, made on a Mold of the Diameter of the Ball: The names of these Ordnance, are Calvering, or French Demi-Cannon, Demi-Cannon Ordinary, Demi-Cannon Royal, French-Cannon, and Cannon-Ordinary; and other names they have, as Bazalisks, &c.

By what is before taught, you may know that the Ladles of Ordnance, though of one Fortification, ought not to be of one pro-

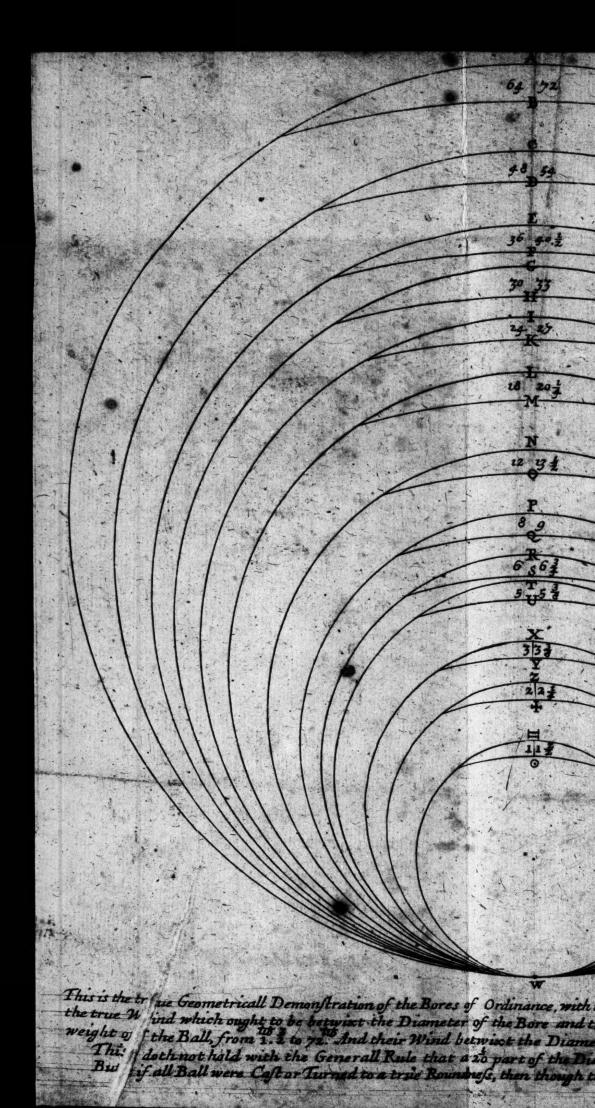
portion.

You must make the Ladles for small Ordnance, viz. from one pound to eight, of three Diameters of the Ball in length, with as much as will nail it on the Ladle-head, and the breadth of those Ladles ought to be of 1 \( \frac{1}{6} \), one Diameter and five sixth parts of the Ball; this Ladle nailed on a wooden head made of purpose, three fills thereof of Powder will serve for Proof, and two fills of Powder will serve for Action to these Guns.

And the Ladles for true-bored, true-Fortified Ordnance, shooting from 8 b ball to 18, ought to be two Diameters and a half of the ball long; with as much as will nail it on the Rammer-head; and the breadth of these Ladles, one and five firth parts of the Diameter of the ball: Three of these Ladles full of powder will serve for proof;

and two full of Powder will ferve for Action.

Also those Ladles for true-bored, true-Fortisted Ordnance that shoot from 18 to ball to 48 to, or 46 to, ought to be two Diameters of the ball long, and one and five sixth parts of the Diameter of the ball broad: Three of these Ladles sull of Powder will serve for proof, and two sull of powder will serve for Action.



mance, with the height of their Ball from 1, to 64. Scots weight, And 1. Bore and the Diameter of & Ball. Likewayes of the English the Diameter of the Ball, and the Diameter of the Bore.

It of the Biameter of the Ball is the Wind for all Guns and though they did only fitt to goe home the less wind & better.

### CHAP. XVI.

A 5 there are true-bored, true-fortified Ordnance both of Brass and Iron; that is to say, 11 fron, and 9 Brass: So there are true-bored Iron Ordnance of 10 Diameters of the Bore in the Breech, and Brass of 8 Diameters of the Bore about the Breech.

And because I know that some Gunners are not acquainted with Arithmetick, (for I have been at Sea with a Gunner that could not read) and so such men use being able to Calculate the Powder of any Guns: Therefore for the publicle good of all, I have taken the pains to calculate Tables for their help; these Tables serve for Iron of to Diameters of the Breech, and may well serve for Brass of 8 of the Breech, as the Figures hereby sheweth; For the Iron Gun is 10 Diameters of the Bore about the Breech, 8 7 at the Ears, and 6 - 2 at the Neck.

The Brais Peece is 8. Diameters of the bore about the Breech, 6. at the Lars, and 4. at the Muzzle: And their Diameters are wrought by the Rule of Archinedo; that is to fay, As 22 is to 7, fo is to, 8. at 6. at 0. at 1. at 1. at 1. at 1. at 1. at 1. at 2. at 1. at

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sh Preside. Conchered look Coleman being Institut with the Staff P. the Powder for Sciencific Cons., Deng. Cons. This Table sheweth Proof-Powder for Iron Ordnance of 10 Diameters of the Bore, and for Brass of 8 17 Diameters of the Bore about the Breech.

This Table sheweth Powder for Action for Iron Ordnance of 10 Diameters of the Bore about the Breech, and for Brass of 8 Diameters about the Breech.

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The Proportion you have in the Copper-Plates, No 3 and 4.

In the last preceding Tables, the first Table, or the Table next your left hand, sheweth the weight of the Ball, in the first, third, and fifth Columns, and is marked with the Letter B; in the second, fourth, and sixth Columns, you have the Powder to prove these Guns, which are marked with the Letter P; being true bored and fortified as before-said.

In the right-hand Table you have the Weight of the Ball, in the first, third, and fifth Columns, marked with the Letter B; and in the second, fourth, and sixth Columns, being marked with the Letter P, the Powder for Action for the Guns, being Fortisted as before-said, either of Brass or Iron.

Now there are Ordnance of Iron Fortified with 9 Diameters of the Bore about the Breech, and Brass of 7 about : And in regard I have feen divers Mistakes about giving them Powder, even of Men professing great Knowledge without Reason; Therefore I will here describe these Tables following, to give them their due Powder. Lower Fortified than 9 of Iron, and 7 of Brass, you shall hardly find a true-bored Peece of Ordnance; The Iron Ordnance being o Diameters of the Bore about the Breech, 7 at the Trunnions, and 5 1 at the Muzzle or Neck; The Brass Ordnance of 7 Diameters of the Bore at the Breech, 5 17 about the Trunnions, and 4 17 at the Neck.

This Table is the Proof for Iron Ord- | This Table is the Pewder for Attion. nance of preDiameters in the for Iron of 9,8 Brafs of 7 Diame-Breech, and Brajs of 7. rers of the Bore about the Breech.

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7 8	3	131	100 Sept 25 Vill				14	. 03	7	2	05	23	150		39		08
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16	6	04	. 32	II	10	42	17	08	16	4	OI	32	7	135	48	II	. 03

The Proportions you have in the Copper Plate, No 5 and 6.

Now as these are the Tables for true-fortified, and lessened in Metal, I hold convenient to give Tables for Reinforc'd Ordnance; these have commonly, being Brass, 10 Diameters of the bore about I 2

the Breech; and Iron 12 about the Breech. And though to some these Tables may seem soolish, I have seen those who have been esteemed. Able Gunners, that knew not how to give such Guns Powder; yea, they have in my presence wagered, and not one of them knew what they wagered concerning two such Guns lying at the Head of Terver confer; where amongst six Gunners, one only understood to give these two Guns their true Powder; as at the Discussion, a Gentleman of the Ordnance to the States did manifest

in favour of the one Man.

I also have been in contest with one professing great Art, and was a rare Person in Art: Yet in the Castle of Edinburgh, there was a Gally-Gun of brass that did shoot 28 th Ball; and thereby he did conclude that Peece to have 13 or 14 to of Powder for Action: In hearing this Expression I did laugh: The Gentleman was offended, and asked if I could teach him? (it was but in diffain): I anfwered, Sir, if you know not better than you express, I am fure I am able to teach you in this Point: Whereupon he went out at the Castle-Gate, and was ever mine Enemy from that time forth. And to farisfy the Reader, I will give the Dimensions of that Peece: She was but 7 Diameters of the Bore about the Breech, and 5 about the Muzzle, for the was plain without Rings, except the Base and Muzzle-Rings, or Cornish-Rings; so that by her Fortification the could fuffer but 6 th and 13 ounces of Powder; and with so much I have caused her to be discharged divers times, and could do Service with this Peece, which could not be done with a true-Fortified Peece; for with this Peece I have that over the Steeple of Edinburgh, and the Ball hath fallen at the next Lodging where Cromwel did lye. And this I did for three times together. Therefore I fay, An able Man may be mistaken of a Gun, when he neither knoweth the Fortification nor Proportion how to work to give a Peece Powder.

So to avoid trouble to Artists for Calculating, and to instruct these Gunners that are not capable of Calculation, I have here fer down the Demonstration of these Guns of Iron, having 12 about the Breech, and Brass having near 10 Diameters about the Breech, and are called Reinforc'd Ordnance. The Figures following demonstrate the true Proportion of these Reinforc'd Ordnance which require more Powder than true-Bored, true-Fortisted Ordnance, as you may see by the Tables following; which Tables might have been first of all: But I observe, that the Ground-Rule must be put in the first place; And those that do take their Dimensions from it

do follow, whether they be Reinforc'd or lessened of Metal, such

as are formerly described.

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These following Tables, are Tables for Reinforc'd Ordnance, which are such as have more strength of Fortification, and are more able to endure string; such as the Bazilisk, Serpents, or Slings, &c. and are good to shoot with at a great distance. Having, as I suppose, given a sull account of the true allowance of Powder for all sorts of true-Bored Ordnance, both for Proof and Action, whether they be Brass or Iron Guns, it followeth that the Gunner ought to know how to go to work with his Peece, when he is to apply these Tables, by which he is to give fire.

First, he shall take a piece of Twine, which is to be well waxed,

as the Shoemakers do their Thread, that it do not

stretch nor shrink; then measure the Peece about These Rules are to at the Touch-hole betwixt the Rings, and taking be observed.

with a pair of Compasses the Diameter of the Bore

at the Muzzle, measure the Twine how many Diameters of the Bore is contained about the Breech of the Peece, that keep in memory. Now you are to know what Ball fits that Peece, as is plainly set down in pag. 34. Geometrically; but may be exactly found in the Tables of Height and Weight of Shot, and in the Tables of Diameters of Bores, either Scots or English. When you have found the Diameter of the Ball, if you cannot Arithmetically find the Weight by the Diameter of the Ball, then you may resort to the Tables for such Fortifications, and next the weight of Ball you have the weight of Powder for that Peece: but you must be sure your Peece must be true-bored, as is mentioned in pag. 47. For if the Peece be either Taper'd, Chamber'd, on Trumpet-bored, these Tables will do no service.

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the Bener P. being tous-bored and P ; being true based and for i-

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Proof-Powder for Reinforced Ord- Powder for Action of Reinforc'd nance, or Iron Guns of 12 Dia- Ordnance, or Iron Guns of 12 meters of the Bore about the Breech, and Brass Guns near 10 Diameters,

Diameters of the Bore about the Breech; and Brass near 10 Diameters about the Breech.

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3	3	ÌO	19	16	07	35	30	08	3	2.	41	19	LI	OI	35	20	08
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9	II	06	25	21	09	41	35	1.2	9	6	10	25	14	08	41	23	12
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In this Table you have the weight of Ball, in the first, third, weight of Ball, in the first, third, and fifth Columns, and is marked and fifth Columns, marked with with the Letter B; and in the fe- the Letter B; and in the fecond cond, fourth, and fixth Columns, fourth, and fixth Columns, you you have the Powder to prove have the Powder for Action, these Guns, which is marked with which is marked with the Letter the Letter P, being true-bored and P; being true bored and forti-Fortified, as above-written.

fied, as above-written.

These Proportions you have in the Copper-Plate, No 7 and 8.

# CHAP. XVII. To find the Weight of an Iron Ball in English Inches Arithmetically for Scots Weight.

To R those that cannot find the Weight of the Ball by Arithmetick, I will here shew them a Rule, and also Tables which I have Calculated, as well Decimally, as in Pounds, Ounces and Drams, from eight parts, to eight of an Inch of the Diameter of a Ball, unto 10 Inches Diameter, both in Scots and English Weight, and also in Scots and English Inches, for the Artificial Gunner his more ease.

It falls out many times that the Gunner cannot find Weights and Scales to weigh his Shot; it is therefore necessary the Gunner should know how to find the Weight of his Shot Arithmetically; as thus, If you desire to know the Weight of a Ball, whose Diameter is just Inches, without any Fraction or parts of an Inch, then you are to multiply the Diameter Cubically; then double that Product, and divide the Total by 16, you have in the Quotient the Pounds that the Ball weigheth; and what Remainer you have over, you shall know that Remainer is Ounces.

Example. There is a Ball of 4 Inches Diameter given, to find his Weight: The Cube of 4 is 64, which being doubled maketh 128; this 128 being divided by 16, (the ounces in a pound) the Quotient giveth 8, which is 8 th of Scots Weight which that Ball doth weigh.

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64	Eig	of that I	of Scots	weight	is the tru	e weigh
128	in the fi	3 and the	Quisias	vad pol	Halde Te	ne of

And because every Gunner hath not Arithmetick at his Fingers ends, and also to ease the Artificial Gunner, I have taken the pains to Calculate these following Tables, both of Scots and English Weight and Measure, or as before faid. I do not take them on trust as others do, but have Calculated them my self from the Ground-Rules, and have given Credit to none, because I never found any yet truly set forth.

Tables for Iron Ball, whose Diameters being measured with English Inches, are exactly Calculated for Scots Weight, from eight parts to eight parts of English Inches, unto ten Inches: Decimally.

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1 1 4 1 7 2 2	00	53638 66992 82397 00000	44	10	77368 59570 46753 39062	61 64 68 7	36 38 40 42	34692 44336 61890 87500	94 94	94 98 102 107	97485 93164 99683 17187
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	101	19946 42383 67456 95312	44	13	36645 39648 48218 62500	71 74 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	47.		97	115	45825 85742 37085

In this Table you have eight Columns; in the first, third, fifth and seventh Columns, there are the Inches, and eight parts of Inches that the Diameter of the Ball doth contain, and are marked with the Letter B: And in the second, fourth, fixth, and eighth Columns, you have the weight of these Diameters of Iron Ball in Scots Weight; under Li. you have Pounds; and under Parts, you have the Decimal parts of Pounds.

Tables

Tables for Iron Ball, whose Diameters being measured with English Inches, are exactly Calculated for Scots Weight, in Pounds, Ounces and Drams, from eight parts to eight parts of English Inches, unto 10 Inches.

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212 218 214 28 24 28	01 02 02 02	15 04 09 15	04 03 09 08	715 101 21	5 1 1 8 4 4 7 8 5 4 4 7 8	20 22 23 25	12 03 12 05	12 15 03 09		8 8 8 4 1 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	76 80 83 87	12 03 11 06	04 04 13 01
3 3 3 4 3 8	03 03 94 04	06 13 04 12	00 00 10 14	or .	6 6 4 6 1 6 1 6 1 6 1 6 1 6 1 6 1 6 1 6	27 28 30 32	00 11 08 06	00 09 04 03		9 9 9 9 9 9 9 9	91 94 98 102	02 15 14 15	00 10 14 15
34	05 05 06 07	05 15 09 04	12 04 07 06	one of		34 36 38 40	05 05 07 09	04 09 01 14	ıl this	91 91 91 94 97		97 13	11 05 11

In this Table you have fix Columns, in the first, third, and fifth Columns, there are the Inches, and eight parts of Inches that the Diameter of the ball doth contain, and are marked with the Letter B; and in the second, fourth, and fixth Columns, you have the Weight of these Diameters of Iron ball in Scots Weight; under Livyou have Pounds, under On. Ounces, and under Dr. Drams.

The Height-Rule you have on the fide of the Quadrant, which proves this Table.

This will be Admirable to some Gunners, and especially English, because their Weight and the Scots Weight doth not hold alike; I have perused the Tables of Weight by most of the Authors of Gunnery, and I find them all to agree, and hold firm, as Mr. Nye writeth. But indeed I find nothing of ingenuity, for a Man to copy a Table from anothers Works, and never examine the Truth of the Work; but I have made use of their own Ground-Rule, and find not one of them to have wrought it, or set the Table down truly.

I will here fet down the Ground-Rule by which they are to make their Table, that the Ingenious Gunner may Correct it himself at his

pleafure.

Thus they fet it down, 2 Inches Diameter give 1 pound 1 ounce. Now having this for a Rule, you may, if you please make a Table.

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The supplier		8 8 4 CHA
200	44 20 11	
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If 2 give		Inches.		n. Dr.
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512	100	729	105.	22
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to le		12393.	1680	I44

Where you see, if 2 Inches give one pound one ounce, 2! Inches giveth 1 pound, 8 ounces, and 3 drams, whereof 16 make an ounce. And by their Tables, because they would be near the Right, they set down 4 Inches to give 8 pound 15 ounces; where by this Work will be but 8 pound 8 ounces.

Weight of these Diameters of Iron ball in Scots Weight; under the Pounds, under On Cances, and taker Dr. Diameters.

The Meight-Rule you have on the rot of the

proves this Table.

100 93657 4

The trueft Rule.

But there is another more fure way, by this Work following : Say, As 2 Inches is to one pound two ounces: So is the Diameter given, unto the Weight required. Example.

	ror ey tois	KHIE I DAVE CA	ichiatea the	T WOLC !	mowing.	4109.2	
A.c	Inches	tb.	Inches.	so is	Tacoo	Co.	
InPra.	2	T 72		40 24	00110	50	- 54 - 64
7-17-0	20 2		3		SATOO.	00	
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oric	co 18 18	11482 - 2123	216	201 4	scons	00	
artor					Dours	Co.	5
UNEOG:	80 (8) 6	teration of		8c. 1	and he	-00	
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		Carrier Constraint or address magazine reside	The state of the state of	metro I rouge	surement - constitution and	supplement :	
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	)486	60020	7.7	3	3
	-	which we so who		16	4
	See 1	Car reserved	We do to Arrivati	-	The state of the state of

16)60(3 fb 12 ounces, 12 drams 48 or 1 of an ounce.

in this Tubly you keep slope Constitute in the first third, All I and several to come under the best production and best best best best than the Diameter of the Ball-Roch contain; and are medical with the

etter B.; sadan the federal; federal; hach; and or his Colonias; non

inder to Walging the territory of the Bull & English Weight a is producted in the wing recording an about the conjugation

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Tables for Iron Ball, whose Diameters being measured with English Inches, are exactly Calculated Decimally for English Weight; from eight parts to eight parts of English Inches, unto 10 Inches.

В	Li.	Parts.	B	Li.	Parts.	B	Li.	Parts.	B	Li,	Parts.
108 14 100 112	00	00027 00220 00742 01758	24/27/8	02 02 03 03	54361 92456 34177 79687	510 510 510 510 510 510 510 510 510 510	18 20 21 23	92972 34888 83725 39648	75 73 747 75 8	62 65 68 72	34219 45874 67746
5 8 1 4 7 8 I	00	03433 05933 09421 14062	38	04 04 05 06	29153 82739 40610 02930	5 5 4 5 E	25 26 28 30	02823 73413 51584 37500	81 81 81 81 81 81	75 78 82 86	42801 96313 60703 36133
1 8 1 4 4 1 1 2 1 2 1 2 1 2 2 1 2 2 2 2 2 2	00 00 00	20023 27466 36557 47461	34	06 07 08 09	69864 41577 18234 00000	61 64 63 63	32 34 36 38	31336 33228 43369 61914	81 83 84 87 9	90 94 98 102	22769 20776 30319 51562
1 1 4 1 7 2	00 00 00	60342 75366 92697 12500	48	09 10 11 12	87039 79517 77597 81445	61 61 67	40 43 45 48	89029 24878 69626 23437	91 91 91 91	111	84671 29810 87143 56836
23	01 01 01 02	34940 60181 88388 19727	483474	13 15 16 17	91226 07104 29245 57812	7 to	50 53 56 59	86478 58911 40903 32617	97	125 130 135 140	39053 33960 41721 62500

In this Table you have eight Columns, in the first, third, fifth, and seventh Columns, are the Inches and eight parts of Inches that the Diameter of the Ball doth contain, and are marked with the Letter B; and in the second, fourth, sixth, and eighth Columns, you have the Weight of these Diameters of Iron Ball in English Weight: under Li. you have pounds, and under parts, you have the Decimal parts of pounds.

Tables for Iron Ball, whose Diameters being measured with English Inches, are exactly Calculated for English Weight, in Pounds, Ounces and Drams, from eight parts to eight parts of English Inches, unto 10 Inches.

B	Li.	On.	Dr.	नात भव	B	Li.	On.	Dr.	31000	B	Li.	On.	Dr.
1	00	. 02	04	N 1 30 251	41	00	00	00	1 Thomas	7	48	03	12
1 1	00	03	03		4	09	13	15		7:	50	13	13
14	00	04	06		41	10	12	12	Lette	74	53	09	07
17	00	05	14		43	11	12	07	***	71	56	06	09
1 1	00	07	10		4:	12	13	00	817	7:	59	05	03
1 2	00	09	10		4	13	14	10		75	62	05	08
14	00	112	QI	nex just	44	15	01	02		73	65	07	05
17	00	14	13.	53. 783	4.3	16	04	- 11	a sele	77	68	10	13
2	OI	02	00	139/	5	17	09	04		8	72	00	00
21	10	05	09		51	18	14	14		8;	75	06	14
24	01	09	10		54	20	05			84	78	15.	07
23	01	14	02		5+	21	13	06		8	82	09	11
21/2	02	03	03	( ·	51	23	06	05		8;	86	05	13
25	02	08	II		51	25	00	07		85	90	03:	10
2 4	02	14	13	par og	54	26	11		Pandar	84	94	03	05
27	03	05	.07		53	28	08	- 04	ID WILLE	82	98	04	14
3	03	12	12		6	30	06	00		9			04
3 %	04	04	11		6	32	05	.00		9			09
34	04	13	04		6;	34	05	05		91	111	04	12
33	105	06	08	Buch	61	36	06	15:		91	115	13	15
31	06	00	08	nedgates a Million a	6:	38	09	14		9:	120	09	02
31	06	11	03	21 .	6:	40	14	04		91	125	05	04
34	07		yo	Miles Committee of the	61	43	-04	00		94	130	05	07
37	08	02	15	T	67	45	11	92	* * * * * * * * * * * * * * * * * * *	197	135	06	11

In this Table you have fix Columns, in the first, third, and fifth Columns, there are the Inches and eight parts of Inches, that the Diameter of the Ball doth contain, and are marked with the Letter B; and in the second, fourth, and fixth Columns, you have the Weight of these Diameters of Iron Ball in English weight; under Li. you have pounds, under On. Ounces, and under Dr. you have Drams.

This Height-Rule you have on the fide of the Quadrant.

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Example. As in the preceeding Example, 3 Inches Diameter giver oth 3 pound 12 ounces and 12 drams, as you may fee by the Work.

Alfo I demand what giveth 4 Inches of Diameter. co

	ib. Incl	00 4 nes. :	1 (1) 1 (1)		00
4 10 2 2 10 3	18 00 <del>21</del> 01 <b>16</b> 20 14	2252	(244(9	on.	00 00 80
20 22 8 14 8 14 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	512 512 512 5132	wlnA	er, it giv		16.

Example. If 4 Inches of Diameter give 9 pound weight, what shall 8 Inches give? Answer, 72 pound.

Inches.	Ib. Inches.	
61 0504 01 2	9 8	
4	8	250 109 151
16	64	)4608 (72 th.
GO 0014,00	€ 5 8 cm	100 00 2
64	512	128
	9.	**************************************
A. to Shart . Jose	4608	ist did although aid

desired of the Ball desired and and are compact to the second

# Another Example with a Fraction.

# If 4 Inches of Diameter give 9 pound, what shall 6 4 Inches give?

Inches.		inches.	14.2 m.l	16 69	1 43 lb.
4 02	0402	27	40257	764	(m. 100 mg)
16	138 3807	27	\$4501, \$400.00	4	Service Colo
96	12 6:31-	189 54 256			Ounces.
256	9926   6   8   8   9   9   9   9   9   9   9   9	729	2354	10	20100 00 00 00 00 00 00 00 00 00 00 00 00
	118 0086	5103	2304		00   00   00   00   00   00   00   00
26 42012	44660	9683	507 256	30 6	28062 OB
\$ 12.00	\$0 ×000	9	251		sores co
The letter	1	7147	TENERS OF	701741	83000 00

I Answer this Ball of 6 1 Inches Diameter, weigherh 43 pound 4 ounces fere; which proves both the Work and Tables to be true and just.

Observation. It is to be observed, That as there is a difference between Scots and English Weight, viz. as 8 to 9, which was mentioned in pag. 44. so is there likewise a difference between Scots and English Inches, which is as 9 to 10; that is to say, 9 English Inches make 10 Scots Inches; as it appeareth in the Tables following.

that the Biameter of the Each cocious, and are nathed on he can the Can percent of the Can percent of the cocious to the Can Land, you know the reaght to the Called Lands of the Lands of the Canada Society and under Free, you seems to the Canada Society and under Free, you

ables the thecimal parts of Pounds.

Tables

Tables for Iron Ball, whose Diameters being measured with Scots Inches, are exactly Calculated Decimally for Scots Weight, from eight parts to eight parts of Scots Inches, unto ten Inches.

B	Li.	Parts.	B	Li.	Parts.	В	Li.	Parts.	В	Li.	Parts.
-18 -4 -18 -18	00	00018 00142 00481 01139	21 24 28 3	01 01 02 02	64826 89512 16546 46037	ではないかられ	12 13 14 15	26646 18607 15054 16092	75 77 78 8	40 42 44 46	39774 41726 50299 65600
3 8 A 4 7 18 I	00	02225 03844 06105 09112	3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1	02 03 03 03	78091 12815 50315 90698	9 4445	16 17 18 19	21829 32372 47826 68300	0 80 80 80 80 80 80 80 80 80 80 80 80 80	48 51 53 55	48877 16811 52935 96214
1 8 1 4 3 8 7 E		12975 17798 23689 30755	31 34 37 4	B (CCC)6500,42150	34072 80542 30216 83200	61666	20 22 23 25	93899 24731 60903 02520	81 81 81 87 87 9	58 61 63 66	46754 04663 70047 43012
1583478	00	39102 48837 60068 72900	4	06	39601 99527 63083 39377	64 63	28	49691 02521 61118 25587		72	23667 12117 08469 12830
24 2 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	OI	87441 03797 22075 42383	44	09 09 10 11	01515 76604 55751 39062	73		96038 72574 55305 44336	94	84	25307 46006 75035 12500

In this Table you have eight Columns; in the first, third, fifth and seventh Columns, there are the Inches, and eight parts of Inches that the Diameter of the Ball doth contain, and are marked with the Letter B: And in the second, fourth, sixth, and eighth Columns, you have the weight of these Diameters of Iron Ball in Scots Weight; under Li. you have Pounds; and under Parts, you have the Decimal parts of Pounds.

Tables

Tables for Iron Ball, whose Diameters being measured with Scots Inthes, are exactly Calculated for Scots Weight, in Pounds, Ounces and Drams, from eight parts to eight parts of Scots Inches, unto to Inches.

B	Li.	On	Dr.		1 B	111	On	Dr.	1	ST COMM	1 PM 20	O Inc	
	-	<u> </u>				150	OII.	Di.	Section of	D	Li.	Un.	Uı
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1 1	00	02	01		4	06	06	05		7:	32	13	0
14	00	02	14		4	06	15	<b>∞</b> 06		7.	34	11	1
ı	00	/03	.45		41	97	10	01	tared at the	71	36	08	, I.
I \$	00	04	15		4:	08	04	14	* _	7;	38	07	0
ıļ	00	06	04		4.	00	00	04	1	74	40	06	0
14	00	07	13		44	09	12	04		71	42	06	I
17	00	09	10		14	10	08	15		72	44	08	0
2	00	11	TI	17 14 M	5	II	06	04	40 14	8	46	10	0
1	00	14	00	46	54	12	04	405		8:	48	97	Ī
4	OI	00	10		64	13	02	15		84	51	02	1
2;	01	03	09		51	14	02	97		8.	53	08	0
2 2	10	<b>0</b> 6	13		Sŧ	15	02	09		8;	55	15	00
1	10	10	06		51	16	03	08		8	58	07	. 0
4	01	-14	05		5.	17	95	03		81	61	00	ì.
7	02	02	10		52	18	97	10		87	63	11	0
}	02	07	06		6	19	10	15	***	9	66	06	14
8	02	12	08		6:	20	13	00	4	10:	69	03	1
4	03	02	01		61	22	03	15		9:	72	OL	7
3	03	-68	10	TAT	6	23	9	12		91	75	OI	06
1	03	14	08		6:	25	00	06		9:	78	02	01
1	04	05	07		DESTRUCTIONS	26	07	15		91	81	04	OJ
3	04	12	14	" Albania M	500000000 a00 ft	28	00	00	S. J. Alex	92	84	07	ot
1	05	04	131	Hard ha	61	29	09	12		97	87	12	"OC

In this Table you have fix Columns, in the first, third, and fish Columns, there are the Inches and eight parts of Inches that the Diameter of the Ball doth contain, and are marked with the Letter B; and in the second, fourth, and fixth Columns, you have the Weight of these Diameters of Iron Ball in Scots weight; under Li. you have pounds, under On. Ounces, and under Dr. you have Drams.

Tables for Iron Ball, whose Diameters being measured with Scots Inches, are exactly Calculated for English Weight, from eight parts to eight parts of Scots Inches, unto ten Inches, Docimally.

B	Li,	Parts.	B	Li.	Parts.	B	Li,	Parts.	В	Li.	Parts
	60 60 60	00020 00160 00541 01281	21/2 2 3 -	01 02 02 02	85429 13200 43611 76792	13	13 14 17	79976 83433 91936 <b>056</b> 04	77778	45 45 60 52	44740 71942 06587 48800
The day of	00	02503 04325 06868 10253	34 34 34 34 34	03 03 03 04	12853 51917 94105 39536	544 547 6	18 19 20 22	24558 48918 78805 14337		157	98702 36412 22052 9574
時は日曜	00 00 00 00	14596 20023 26650 34599	34	04 05 05 06	88331 40610 96493 56100	9898	23 25 26 28	55637 02823 56016 15335	84 87		77600 67740 6630: 73389
時は将工	00 00 00 00	43990 54942 67576 82012	44 44 44 44	07 07 08 09	19552 86968 58468 34174	61 62 7	29 31 33 35	80902 52836 31257 16286	91	81	8912 13631 2702 89433
2	01 01 01	98371 16772 37335 60181	43	10 10 11 12	14204 98680 87720 81445	777777777777777777777777777777777777777	39	08042 06646 12218 24870	9 ± 9 ×	98	40976 0175 71912 5156

In this Table you have eight Columns; in the first, third, fifth and seventh Columns, there are the luches, and eight parts of Inches that the Diameter of the Ball doth contain, and are marked with the Letter B: And in the second, fourth, fixth, and eighth Columns, you have the weight of these Diameters of Iroh Ball in English Weight; under Li. you have Pounds; and under Parts, you have the Decimal parts of Pounds.

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Tables for Iron Rall, whose December's being mensioned with Scots In-chas, or e exactly Colombard for English Weighton Pounds, Ounces and

3	Li.	On.	Dr.	1112101	1/8	Hi	On.	De	THE B	15, M		o Inc	
- 4 1 1 1	AF GOSSONIE	01 02 03 04	10 01 03 04		4444	06 07	09 03 13 09	00 02 19 06		P 7 7777	35 37 39	On. 02 01 01	Dr Ic or or
1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	00	5 8 8 5	09 01 13 13		本をおり	09 10 10 11	09 82 15 14	07 04 13 01		777777	43 45 47 50	04 07 11 10	08
2 2 2 2 2 2 2 2	00 10 10	13 15 02 06	02 12 11 00		では、	12 13 14 17	13 12 13 14	00 13 06 11		80000	52 54 57 60	07 15 09 03	13 00 08
21 21 21 21 21 21 21 21	01 01 02 02	09 13 02 07	10 11 02 00		Charles of the Control of the Contro	17 18 19 20	00 03 07 12	14 13 10		00 00 00 00 00 00 00 00 00 00 00 00 00	62 67 68 71	15 12 10	05
3 3 3 3	02 03 03 03	02 08 15	05 05 01	4	6 6 6 6	22 23 25 26	02 08 90 08	05 14 07	er ali er in er in er in	9 0 0	74 77 81 84	14 02 07	14 04 03 08
B 3 3 3 3 3	04 04 05 05	06 14 06 15	05 01 08 07		0 0 0 0 0 0 0 0	18 29 31 33	C-2 1-2 0-8 0-5	07 15 07 00	116		87 91 98	14 66 00	5888

d

es h

- 0 -

In this Table you have fix Columns, in the first, third, and fifth Columns, there are the Inches, and eight parts of Inches that the Diameter of the ball doth contain, and are marked with the Letter B; and in the fecond, fourth, and finth Columns, you have the Weight of these Diameters of Iron ball in English Weight; under Li. you have Pounds, under On. Ounces, and under Dr. Drams.

CHAR

### CHAP. XVII. The Ufa of the preceding Tables.

If the Diameter of an Iron Ball be measured with Scots Inches, I would know what the same Ball weigheth in English Weight.

Example. There is an Iron Ball, whose Diameter is 7 2 Scots In-

ches; I demand what the fame Ball weighs in English Weight.

Look in the Table in pag. 68. under B in the fifth Column, where you find 5. Inches; and right against it, in the fixth Column, you have 17 pound and 1866 pounds, which is the just weight of the same Ball.

Or otherwise, Look in the Table in pag. 69, under B, in the third Column, where you find 5. Inches; and right against it, in the sourch Column, you have 17 pound, so ounces, and 14 drams, which is also the just Weight of the same Ball.

Crif the Diameter of an Iron Ball be measured with Scots Inches; I desire to know what the same Ball weigherh in Scots Weight.

Example. There is an Iron Ball whole Diameter is 6 1 Scots Inches; I demand what doth the fame Ball weigh in Scots Weight.

Look in the Table in pag. 66. under B in the fifth Column, where you find 6. Inches; and right against it, in the fixth Column, you have 20 pound and 100 parts of a pound, which is the just weight

of the same Ball in Scots weight.

Or otherwise, Look in the Table in pag. 67, under B, in the third Column, where you find 64 Inches; and right against it, in the sourth Column, you have 20 pounds and 15 ounces, which is also the just weight of the same Ball in Scots weight. And this I will assure you to be truth, because I have calculated all these Tables with my own Hand, and they are since revised and truly done, by the laborious pains of Mr. Robert Webster.

#### CHAP. XVIII. To extrast the Cube-Ross of a Number not Cubical.

Tou have the Diameter and Weight of Scots and English Ball, on the Scale, on the fide of the Quadrant; Also the Dimension of one side Metal, both Brass and Iron Ordnance; by which you may give powder for Altien.

Doubt not but Men of Reason will think, that in Calculating all these Tables, I have taken great pains, so that you need to take the less: And because there are many Gunners that cannot use their Pen, and some that cannot understand the use of Tables, I therefore for their help will here set down an Height-

Rule for Ball, from one pound to an hundred pound, both in Scots and English Weight. Bur before this Height-Rule be made, it is needful to fet down a Cubical Table, for except you have this Table, the Height-Rule cannot be truly made.

To Calculate this Table, it is necessary that you can Extract the Cube Root of Irrational Numbers; which Numbers are so termed, because that from such Numbers you cannot extract a true Cube-Root, and therefore to the Number propounded you must add 3, 6, or 9 Ciphers; by which you may Extract the Cube-Root without sensible error, as it doth appear in the Examples following.

Example. Let it be required to extract the Cube-Root of 8302348.

Having distributed the Number given into several Cubes by Points, as is directed in Chap. 8. of this. I demand the Cube-Root of 8.

is contained in 30, and not finding it once contained therein, I write

(the first Cube on the left hand) which I find to be 2; wherefore placing 2 in the Quotient. and 8 the Cube thereof, under 8 the first Cuce, I draw a Line, Jubtracting 8 out of 8, the Remainder is o, which I subscribe under the Line. This is always the first Work, and is no more repeated in the whole Extraction, (as was intimated in the third Note of chap. 8); then bringing down the next Cube, (to wit, the Figures standing in the three following places of the Number propounded) which is 302, I place it after the Remainder o, so is 302 the Resolvend; this done, having drawn a Line underneath the Refolvend, I leek for the triple of the Square of the Root, viz. The Root in the Quotient is 2, which multiplied by it felf produceth the Square 4, the triple whereof is 12; this I subscribe under the Resolvend, in luch manner, that the Figure 2 in the Unites place of this triple Square 12, may stand directly under the Figure 3, which is leated in the third place of the Refolvend, (to wit, the place of Hundreds) : Again, I triple the Root 2, which produceth 6, and subscribe this triple Number 6 under the fecond place (or place of Tens) in the Refolvend, to wit, under o; then drawing a Line under the Work, and ad-

of Tens) in the Resolvend, to wit, under 0; 59940 then drawing a Line under the Work, and adding together the said two Numbers last subscribed, as they are ranked, the Sum of them is 126 for a Divisor: That done, esteeming 30, to wit, all the places except the first, or place of Unites, in the Resolvend, as a Dividend, I demand how often the Divisor 126

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o in the Quotient; and now because the sum of the three Numbers which

which ought to have been produced (according as was mentioned in Chap. 8.) by the multiplication of o, (which was last placed in the Quotient) amounts to o, the Refolvend 302, out of which the faid Sum fliould have been fubrracted, remains the fame without alteration; wherefore havingsdrawn a Line under the Work, I write down anew the old Resolvend 302, and bringing down the next Cube, 348, I annex it to the faid 302, fo there will be a new Refolvend, to wit, 302348. Then iquaring the Root 20, (that is, multiplying of it by it felf) the Product is 400; which I triple, or multiply by 3, and fubicribe the Product 1200 under the new Refolvend in fuch manner, that the place of Unites in this triple Quadrate 1200 may fland under the place of Hundreds, or third place of the Refolvend 302348, to wit, under 3. Again, I subscribe the triple of the Root 20, which is 60, in such manner, that the place of Unites in this triple Root 60-may fland under the place of Tens, or second place of the Resolvend; then adding together the two Numbers last subscribed, to wit, 1200 and 60, in such order as they are ranked in the Work, the Sum is 12060 for a Divisor. Again, esteeming the whole Refolvend, except the first place, (or place of Units) as a Dividend, to wit, 30234, I demand how often I (the first Figure of the Divisor towards the less hand) is contained in 3, the correspondent part of the Dividend; and though it be ; times contained in it, yet (according to the first Note in Chap. 8. I dare take but 2; for if I should take 3, and proceed according as was declared in Chap. 8. a Number would arife greater than the Refolyend, from which fuch Numbers arising ought to be subtracted) wherefore I write 2 in the Quotient. Then multiplying the triple Square 1200 before subscribed by 2, (the Figure last placed in the Quotient) the product is 2400, which I subscribe under the faid 1200, (to wit) Units under Units, and Tens under Tens, &c. Also multiplying the triple Root 60, before subscribed by 4; (the Quadrate of 2, the Figure last placed in the Quotient) the Product is 240, which I subscribe under the said triple Root 60; last of all I subscribe 8 the Cube of the faid new Root 2, under the place of Units, or first place of the Resolvend, to wit, under 8; and having added together those three Numbers last subscribed, to wit, 2400, 240, and 8, as they stand in Ranks in the Work, the fum of them is 242408, which being deducted from the Resolvend 302348, there will remain 50940. Wherefore the Work being finished. I find 202 to be the number of Units contained in the Cube Root of 8302348 the number propounded: and because, after the Extraction is ended, there happens to be a Remainder, to wit, 59940, I conclude that the Cure-Root fought is greater than the faid 202, but less than 203; yet how much it is greater than 202, no Rules of Art hitherto known will exactly discover, althow we may proceed infinitely near, as by the following Rule will be manifest.

## To find the Fractional part of the Root very wear.

Ternaries of Ciphers, to wit, 000, 000000, or 000000000, &c. are to be annexed to the Number first propounded then esteeming the Number propounded wish the Ciphers anaexed to be but one entire Number, the Extraction is to be made according as hath : been prescribed in this Chapter; and look how many Points were placed over the Number first given, so many of the foremost places in the Quotient are the Integers or Units contained in the Cube-Root fought, and the places in the Quotient are to be esteemed as the Numerator of a Decimal Fraction; which Numerator confilts: of so many places as there were Points over the Ciphers first annexed: fo if 8302348 were given, as before, to find the Cube-Root thereof, (according to this Rule) annex Ciphers, as you here fee in the Work. And then if you profecute the Extraction according to the Rules foregoing, you shall find the Cube-Root fought to be 202 48, &c. that is, 202 7 and more; wherefore you may conclude that 202 . is less than the true Root, but 202 is greater than it; So that by annexing two Ternaries of Ciphers, to wit, fix Ciphers to the number propounded, you will not mils ... part of an Unite of the true Root; as also by annexing three Ternaries of Ciphers, to wit, o Ciphers, you will not mits part of an Unite of the true Root; and in that order you may proceed infinitely near, when you cannot obtain the true Root. The whole Operation of the faid Example you have in the next Fage, where you may observe, that for the more certain and easie placing, as well of the numbers, which constitute the leveral Divisors, as of those which constitute the Ablatitious Numbers to be subtracted from the several and respective Resolvends, down right Lines are drawn between the farticular Cubes of the Number propounded, first distinguished by the following Example.

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Another Example wrought by the Genitures.

In like manner the Cube-Root of 2, will be found to be near equal to 1125992, &c. that is, 1 1550500 parts and more. And the Work will stand thus:

1—300— 1—30—	- 2 600 - 4 120	omavi Spelit	1 9 1 9 1 T
·	8  8 728- - 5 216000	1 272 878	99 942 8 8 221 2 1 512 999 999 999
12 30	25 9000 125 125	1 2 5	9 9 2
15625 300 125 30	225125 9 42187500 81 303750 729 729	225 491 42 282 4 85	979 799 488 778 392 242 di lo comp fici
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The Proof of the Cube-Root.

The Extraction of the Cube-Root is proved by multiplying the Root Cubically; to wit, the Root being first multiplied by it self, the Product shall give a Square Number, the which Square being multiplied again by the faid Root, the Number arising, or last Pro-.duct duct (in case there be no Remainder after the Extraction is finished) will be equal to the Number propounded:

So in the Example of Chap. 8, the Cube-Root 54 being multiplyed first by it self, produceth 2916, which is a Square Number, then the said Square 2916, being multiplyed by the Root 54, produceth 157464, which is a Cube Number equal to the Number propounded, whose Cube-Root was required. So that the Extraction is right, and the same Root found is the true Cube-Root of the Number proposed. But when after the Extraction is finished, there happens to be a Remainder, and that the Root is found as near as you please in Integers and Decimal parts, (by annexing Ciphers as in this Chapter) then such mixt Number expressing the Root, being multiplyed.

Cubically, must produce a mixt Number, less than the Number first propounded; yet so near unto it, that if the Figure standing in the last place of the Decimal Fraction in the Root be made greater by 1, and the mixt number so increased be multiplyed Cubically, the Product must be greater than the Number first propounded: So in the first Example of this Chapter, if 202[48 be multiplyed Cubically, it produceth 8301305[49, 60. which is less than the propounded Number 8302348; but if 202[49 be multiplyed Cubically, there will arise 8302535[49, 60. which is greater than the

faid given Number. Example.

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The Table of Cubes, whereby the Height-Rule is made. This Height Rule you have on the side of the Quadrant-Rule, both for Scots and English Ball.

A	B	A	В	A	B	A	B	A	В
I	1000	26	2962	51	3708	76	4235	101	4657
2	1259	27	3000	52.	3732	77	4254	102	4672
3	1442	28	3036	53	3756	78	4272	103	4687
4	1587	29	3072	54	3779	79	4290	104	4702
2	1709	30	3107	55	3802	80	4308	105	4717
6	1817	34	3141	56	3825	81	4326	106	4732
7	1912	32	3174	57	3848	82	4344	107	4747
8	2000	33	3207	58	3870	83		108	4762
9	2080	34	3239	59	3892	84	4379	109	4776
10	2154	35	3271	60	3914	85	4396	110	4791
11	2223	36	3301	61	3936	86	4413	111	480
12	2289	37	3332	62	3957	. 87	4430	112	4820
13		38	3361	63	3979	88	4447	113	4834
	2410	39	3391	64	4000	89	4464	114	4847
15	2466	40	3419	65	4020	90	4485	115	4862
16	2519	41	3448	66	4041	91	The second secon	116	4877
17	2571	42	3476	67	4061		4514	1117	4890
18	2620	43	3503	68	4081	93	4530	118	4904
19	2668	44	3530	69	4101	Control of the Contro	4546	119	4918
20	2714	45	3556	70	4121	95	4562	120	4931
21	2758	46	3583	71	4140	96	4578	121	The second second
22	2802	47	3608	72	4160	97	4594	122	4946
23	2843	48	3634	73	4179	98	4610	123	4959
24	2884	49	3659	74	4198	99	4626	124	4973
25	2924	150	3689	75		100	4642	125	5000

In this Table you have ten Columns, in the first, third, fifth, seventh and ninth Columns, you have the weight of Ball, from 1 15 to 125 15, and are marked with the Letter A; and in the second, sourth, sixth, eighth, and tenth Columns, you have the Cube-Roots and Parts correspondent to the Weight of Ball, which are marked with the Letter B; as shall appear in the Examples following.

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CHAP

CHAP. XIX. The way to find the Diameter of the first pound Ball.

Scale to know the Weight of his Shot, by measuring the Diameter of the Ball, and by this Cubical Table: First he must know the exact Diameter of a Ball of one pound weight, of what fort of Metal or Stone he desires his Height-Rule or Scale for; the which to

do, observe these Rules following.

First, Search until you find a Ball of that Metal very smooth, of any fize or weight, and take the Diameter exactly of that Ball, with a pair of Callabassero Compasses. Then draw that Diameter on a piece of a Paper, or plain Board, and divide it into as many equal parts as you please: then weigh that Ball exactly well, which being done, multiply the Divisions of the Diameter of the Ball Cubically, and divide that Product by the weight of the Ball; so from that Quotient of your Division, you are to extract the Cube-Root, and the Quotient is the parts of that Ball which weigheth one pound weight of that Metal.

Example. The Ball given is a Ball of Iron, whose weight is 12 16; and his Diameter is divided into 300 equal parts; which done, work

as followeth:

B

D

By which I find 131 parts of the Ball given, to be the just Diameter of a Ball of one pound weight, of that Country-Weight. As you may see by the Diameters herewith annexed; the Line AB the Diameter of the Ball given, and the Line CD the Ball found for one pound.

After

After you have found the true Diameter of one pound Ball, you must divide the same into 1000 equal parts; or make a Diagonal Scale of the same Diameter of the one pound Ball, and so resort to the Table of Cubical Numbers; and having a Scale of Paper or Wood ready, you may set the Diameter of the Ball on it, from one pound as far as the Table doth run.

And that I may make it the more plain, behold the Diameter of a

Ball of 12 pound; and from that, by working as is before taught, you may have the Diameter of one pound Ball, which is here found, and true in every Condition. Thus having the Table of Cubical Numbers, wherein you find the first pound is 1000 in its Root, and the se-

The Demonstration and Diameter of a Ball of 12 pound being given, the Diameter of one pound Ball is also given, as in pag. 78.

cond 1259 of the parts of one pound Ball, which is 250 parts more than the Ball of one pound; which added to the Diameter of one pound, gives the Diameter of a Ball of 2 pound; which place on your Ruler, then the Table gives 1442, for the Diameter of a Ball of 3 pound; and if you take 442, and add to the Diameter of one pound Ball, you have the Diameter of a Ball of 3 pound: And thus you may increase and go upward till you have a compleat Height-Rule of what height you please.

So making it, as you are taught, you may answer any Question demanded of the Weight of Ball, of the Metal and Weights of the place it is made for. For all places have not one Weight, as you

fee by the Table following.

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## The Proof of the Height-Rule.

Now every Height-Rule for Ball, of what Metal soever it be made for, is proved in manner following: That when you extend your Compasses to the height of one pound, and with the same extention turn your Compasses, you shall reach 8 pound; and if you take the Diameter of a 2 pound Ball, and turn the Compasses about, must fall in 16 pound Ball; and of 3 pound to 24 pound: So that all Ball being twice the Diameter of the other, must carry 8 times the weight of the other.

Furthermore, By the Cubical Table, with the Diagonal Scale of the heighth of one pound Ball, you may give an account to make Height-Rules, shewing the Weight of Iron Ball in any Place or Country, knowing the proportion it beareth with our own Scots or English Weight: So that here it will be very requisite, in regard Demonstration and

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ordinarily every Country have their own distinct Weights and Meafures, to give a Catalogue of some several Places, and their Weights, compared with ours as you see, and as shall be further demonstraed for the Gunner's more ease.

# Table of the Weights of Several Places being compared with ours of Edinburgh.

	and from rust, by your ting	
	London -	112
	Antwerp	108
353833	Bollogue, betwixt 139 and -	140
1200	Catalogne	
	Cullen Thursday Contract.	102
nds	Cwellend and le a	08
n- 1	Dantzick -	122
na-<	Florence	142
	Lubeck	
hu 14	Lyons.	120
3 PE	Genua, betwirt 152 and-	143
00.0	Amsterdam -	100
	Venetia, great Weight -	
iswi	Prague	62
	Lublin	
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31 31 y	的特殊	336
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	9	192

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I set here for Example; There is a Gun in Edinburgh, measured by the Height-Rule, and is found to shoot 36 pound Ball: Now the Question is, What Weight of Ball the same Peece doth shoot at London: And comparing the Weights together, you will find it stand thus.

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And that Peece which shooteth 36 pound Ball at Edinburgh, will require at London a Ball of 40 pound 5 ounces English weight.

Another Example.

Likewise if there were a Peece at Edinburgh, which shoots 9 pound Ball; I would know what the Weight of a Ball sit for that Peece shall be of Dantzick Weight.

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tonian.	कर राज्यानि स्तार क	ece whole Diameter		
You fee	that of that W	eight it will be 10	and rood by	122
			th rol	08
And fo	generally the G	parts of an ounce.	increis a Con at	16
tell with	Ball in all Lisce	Squar work in the	demand I demand	88
		unner may ht him- Sudgit worth work to sees Some labilities	an noing dy which	8
	a mighant to	and mix	Ounces 15	

And as there is a diverfity in the Weights of feveral Places, fo is there likewife a diversity in the Foot : And that here it will be neceffary to give a Catalogue of fome feveral places, and their Feet compared with our Foot.

> A Catalogue of the Feet of Several Places compared with ours of Edinburgh.

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	Of Antwerp95187
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in the far	Of Stratsburgh 94L22

Ouiskaver -- as so stops ! Le Proper on Example. There is a Gun in Edinburgh, whose Diameter of the Bore is measured by the Height-Rule to be 64 Inches; I demand: how many Inches of London shall the Ditmeter of the Bore of the: fame Peece be.

Inches.			ches.	-	Inch	ies.
MOR	20.0	12185	<b>64</b>	er provide tradition	- 2.90	
41		-			51	Inches.
4			35		200	

I Answers,

I Answer, That Peece whose Diameter of the Bore is 64 Inches at Edinburgh, is but 5 1 Inches of Diameter at London.

Another Example.

There is a Gun at London which shooteth a Ball of 64 Inches Diameter; I demand of how many Inches Diameter shall a Ball be at Edinburgh which shall fit the same Peece.

Inches.	Inches.	Inches.	
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	the face: An		
places, and th	of fone leveral		
	3		faw berngeroo nches.

I Answer, That Peece which shooteth a Ball of 6 4 Inches Diameter at London, shall certainly require a Ball to fit her at Edinburgh of 7 4 Inches.

Any Ingenious Gunner observing all the Rules that hath been defcribed in this Chapter, may make an Height-Rule for any Metal of

Ball.

cs 14L68 ces, lo is ill be nenelr Feet

For more clearing of this, I shall set here a Table of equal Diameters and different Weight.

The Diameters of Ball of one Country Weight to be found by equal and several Divisions of several Metals and Stones, as they are compared with Iron.

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asla	Lead			
Too in in	Quickfilver	- as 50	s is to 95	The Proportion of
Iron is in	Gold -	as 8	is to 19	Iron Ball compa-
Propertion -	Tin -	as 120	oisto 111	red with other Me-
tc 10 3108	Marble-	as 9	6 is to 43	rais and Stones.
	Sclate -	as 4	8 is to 13	fame Peece be
	Stone -	as:14	is to 35	Lacios.
	Brick -	as 28	8 is to 65	A COCK TOTAL
nada				

Example.

Example. There is a Gun which shooteth a Ball of Iron weighing 24 pounds; I demand what shall a Ball of Lead of the same Diameter weigh.

1b 3 3 3 69 34 1 1b

I Answer, This Peece shall require a Ball of Lead which weighter 34 pounds and 8 ounces, which shall be of the same Diameter as was the Iron Ball of 24 pounds.

Another Example.

There is a Gun which shooteth a Ball of Ison weighing 36 pounds; I demand what shall a Ball of Stone of the same Diameter weigh.

244 36 35 4 8½ pounds.

1 Answer, This Peece shall require a Ball of Stone which weighter but 8 pounds and 12 ounces, which shall be of the same Diameter as was the Iron Ball of 36 pounds.

#### CHAP. XX

OR the Gunners further ease, I have set down Tables both of Scots and English Weight of Iron Ball, from 1 pound to 100 pounds; with the Diameters of the Ball both in Scots and English Inches, and parts of Inches; together with the Heighth of the Bores of the Ordnance that the same Ball shall sit in the like Inches: So that he may take the Diameter of a Ball, (only knowing the Weight); as also the Heighth of the Bore of the Peece, which the same Ball shall sit, from any Diagonal Scale of Inches, divided into Decimal parts.

Tables for Ivon Ball, wherein you have the Weight of every Ball given in Scots Weight, from 1 th to 100 th; together with the Diameters or Height of every Ball in Scots Inches, and parts of Inches; exactly Calculated to each pound Weight above-mentioned.

A	B	1	A	_B_		A	В	1	A	В
1	2.2222	CONTRACTOR	26	6.5833		51	8.2410		76	9.4129
2	2.7998		27	6.6667		52	8.2944		77	9.4540
3	3.2049		28	6.7480		53	8.3473		78	9.4948
4	3.5276		29	6.8273		54	8.3994		79	9-5351
5	3.8000	23	30	6.9050		55	8.4510	1 -11	80	9.5752
6	4.0380	19	31	6.9808		56	8.5019	2.04	81	9.6150
	4.2509		32	7.0551		57	8.5522	11.00	82	9.6544
7 8	4.4444		33	7.1279		58	8,6019		83	9.6934
9	4.6223		34	7.1991		59	8.6511		84	9,7322
TO	4.7876	Fysic.	35	7.2694	1 11	60	8.6997		85	9.7708
11	4.9421	1	36	7-3377		61	8.7478	11000	86	9.8089
12			37	7:4050	33	62	8.7953		87	9.8468
13	5.2251		38	7.4709		63	8.8423	8.45.6	88	9.8843
14	MEAN PROPERTY OF THE PARTY OF THE	4 6	139			64	8.8889		89	9.9217
15			40	7.5999		65	8.9349		90	9.9587
16	-		41	7.6627	N = 11	-66	8.9806	E min	910	9.9954
17	5.7140		142		J	67	9.0257	) as	92	10.0319
18	5.8238		43		o bu	68	9.0703	1 00	93	10.0681
19			44			69	9.1146		94	10.1041
20			45			70	9.1584	7	95	10.1398
21			46	The same of the sa	17	71	9.2018		96	10.1752
22	A CONTRACTOR OF THE PARTY OF TH		47			72	9.2448		97.	10.2104
2/3		and the	48	8.0761		73	9.2874	e Girc	98	10.2454
	6.4100		49						99	10,2801
	6.4978		190	8.1868		75			100	10.3147

In this Table you have eight Columns, in the first, third, fifth, and seventh Columns, marked with the Letter A, is the Weight of the Ball in Score Weight; and in the second, fourth, fixth, and eighth Columns, marked with the Letter B, you have the Diameter of the Ball in Scors Inches, and Decimal parts of Inches. The Geometrical Demonstration of these two Tables is in pag. 44.

Tables for Iron Ball, wherein you have the Weight of every Ball given in Scots Weight, from 1 to to 100 th; together with the Height of the Bore of each Poece answering to those Balls, given in Scots Inches and parts of Inches; Exactly Calculated to each pound weight of Ball above-mentioned, the Wind being truly extracted.

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A	В	IA	В	A		B 1	1	A	В
1	2.3529	26	6.8695	5	ī	8.5993		76	9.8223
2	2.9645	27	6.9566	5		8.6550		77	9.8650
3	3.3934		7.0414	5		8.7102		78	9.9076
4	3.7351	29	7.1241	5	5000	8.7645		79	9.9497
5	4.0235	30	7.2052	5	5	8.8184		80	9.9915
б	4-2754	31	7.2843	5		8.8715		81	10.0330
7	45010	32	7.3618		7	8.9240		82	10.0742
8	4-7058	33	7.4378	5		8.9759	2	83	10.1149
19	4.8424	34	7.5121	5	9	9.0272		84	10.1553
EO	5.0156	35	7.5855			9:0779		85	10.1956
LI	5.1774	36	7.6567	. 6	ī	9.1281		86	10.2354
12	5.3300	37	7.7270	16	2	9.1777		87	10.2749
13	5.4739	38	7.7957	6	3	APPEAR OF THE PARTY OF THE PART		88	10-3141
14	5.6109	39	7.8637	- 6	4	9.2754		89	10.3531
15	5.7414	40	7.9303		5	9.3234		90	10.3917
16	5.8664	41	7.9959	6	6	9.3711	10	91	10.4300
17	5.9861	42		Company of the Compan	7	9.4181		92	10.4681
18		43	8.1238	6	8	9.4647		93	10.5058
19	6.1876	44	8.1863	6	9	9.5109		94	10.5434
20	6.2943	45	8.2479	1 1/2	10	9.5566		95	10.5807
21	6.3976	46	8.3085	5	71	9.6016		96	10.6176
22	THE RESERVE AND ADDRESS OF THE RESERVE AND ADDRESS.	47	8.3683		12	9.6467	1	97	10.6543
23		48	8.4272		73		10.8	98	10.6909
24	6.6887	49	8.4854		74	THE RESERVE OF THE PARTY OF THE		99	10.7271
25	6.7803	50			75	9,7788	19	100	

In this Table you have eight Columns, in the first third, fifth, and seventh Columns, marked with the Letter A, is the weight of Ball in Scots Weight; and in the second, fourth, sixth, and eighth Columns marked with the Letter B, you have the Height of the Bore of each Peece, which those Balls shall fit, the Wind truly Extracted, in Scots Inches, and Decimal parts of laches: Which you have in the Copper Plate, pag. 46, 47.

Tables for Iron Ball, wherein you have the Weight of every Ball given in English Weight, from 1 th to 100 th; together with the Diameter or Height of every Ball in English Inches, and parts of Inches; exactly Calculated to each pound Weight of Ball above-mentioned.

A	B	A	В		A	B.	1	A	В
1	1.9230	26	5.6969		51	7.1313	1	76	8.1455
2	2.4228	27	5.7690		52	7.1776	5 4	77	8.1811.
3	2.7735	28	5.8394		53	7.2233		78-	8.2163
4	3.0526	29	5:9081	20	54	7.2685	80	79	8.2513
4	3.3883	30	5.9752		55	7.3.131	4.4	80	8.2860
6	3.4943	31	6:0409		56	7-3571		81	8.3203
7	3.6786	32	6.1051		57	7-4007		82	8.3544
8	3.8460	33	6.1681		1 58	7-4437	-	83	8.3883
9	4.0000	34	6.2298		59	7.4862		84	8.4218
10	4.1430	35	6.2903		60	7.5283		85.	8.4551
KI	4.2767	36	6.3496		61	7.9699		86	8.4881
12		37	6.4079		62	7.6110	· 2	87	8.9209
13		38	6.4651		63	7.6517		88	8.5534
14		39	6.5223		64	7.6920	1	89	8.5857
15	4-7425	40			65	7.7318		90	8.6177
16		41	6.6309	1	66	N. Characteristics	0	91	8.6495
17	4 9446	42		1	167		1	92	8.6811
18	5.0397	43	6.7370	×	68	7.8490	١.٠	93	8.7124
13		44	6.7888		69			94	8.7436
20	5.2198	45	6.8399	<b>&gt;</b>	70	7.9252	-	95	8,7744
2	1 5.3054	46	THE RESERVE AND ADDRESS OF THE PARTY OF THE	ACC 25 March 1971	71	A STATE OF THE PARTY OF THE PAR		96	8.8041
2	1 2001	47			72		1	97	8:8356
2	THE RESERVE OF THE PARTY OF THE	48	6.988	5	73	THE SOUR PROPERTY AND THE SOURCE		98	8:8658
2		49	7.036	3	74	TASK RATE AND AND STREET		99	8.8959
12		150	7.084	4	- 7		6	100	8.9258

In this Table you have eight Columns, in the first, third, fifth, and seventh Columns, marked with the Letter A, is the Weight of the Ball in English Weight; and in the second, sourth, sixth, and eighth Columns, marked with the Letter B, you have the Diameter of the Ball in English Inches, and Decimal parts of Inches.

Tables

Tables for Iron Ball, wherein you have the Weight of every Ball given in English Weight; from 1 to 100 th; together with the Height of the Bore of each Peece answering to those Balls, given in English Inches and parts of Inches; Exastly Calculated to each pound weight of Ball above-mentioned, the Wind being truly extracted.

A	B (	AB	A   B'	A	B
1	2.0362	26 5.9446	51 7.4414	76	8.4997
2	2.5653	27 6.0198	12 7.4897	77	8.5368
3	2.9371	28 6.0933	53. 7.5374	78	8.5735
4	3.2322	29 6.1650	54 7.5845	79	8.6101
5	34817	30 6.2350	55 7.6311	80	8.6463
6	3.6998	31 6.3035	56 7.6770	81	8.6821
7	3.8990	32 6.3705	57 7.7225	82	8.7176
8	4-0722	33 6.4363	58 7.7673	83	8.7530
9	4.2353	34 6.5007	59 7.8117	84	8.7880
10	4-3403	35 6.5638	60 7.8956	85	8.8227
11	44804	36 6.6257	61 7.8990	86	8:8577
12		37 6.6865	162 7.9419	87	8.8914
13		38 6.7462	63 7.9844	88	8.9253
14		39 6.8059	64 8.0264	89	8.9590
15	4.9683	40 6.8625	65 8.0680	90	8.9924
16	5.0764	41 6.9192	66 8.1091	91	9.0250
17		42 6.9750	67 8.1500	91	9:0585
18		43 7.0299	68, 8.1903	93.	9.0912
19		44 7.0840	60 8.2302	94	9.1238
20	5.4467	45 7.1373	70 8:2698	95	9.1559
21	5.5361	46,7.1898	71 8.3090	96	9.1879
22		47-7-2415	72 8.3478	97	9,2198
23	是 A TO A RECTOR AND A RESTOR OF THE RESTOR	48 7.2925	73 8.3863	98	9.2513
24		49, 7.3427	74 84244	99	9.2827
2		50,73924	75 8 4622	100	9.3139

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nd e-

les

In this Table you have eight Columns, in the first, third, fifth, and seventh Columns, marked with the Letter A, with weight of Ball in English Weight; and in the second, fourth, fixth, and eighth Columns marked with the Letter B, you have the Height of the Bore of each Peece, which those Balls shall fit, the Windtruly extracted, in English loches, and Decimal parts of Inches: Which you have in the Copper Piece herewith.

Thus having both Arithmetically, and by Tables, given Instructions how to make an Height or Diameter-Rule for Ball; and likewise having shown both Arithmetically, Geometrically, and by Tables, how to deduct the Wind from the Bore of a Peece, thereby to know her true Diameter of Ball; and having given Tables of the Weight of Ball by their Diameters; Therefore it follows, by the Weight of the Ball and Fortification of the Peece, that all Ordnance have their Powder either for Proof or Action.

And, as I have shown by the Tables, all Brass or Iron Ordnance ought to have their Powder to their Proof; for True-bored Ordnance, and True-fortified, the Weight of their Ball from 1 to 8 th, and from 8 to 18 three quarters of their Balls Weight; and from 18 to 48, two third parts of the Weight of the Ball, and so

infinitely.

For their Ordinary, follow the Tables where you may ferve suffi-

ciently, and fave Powder.

For Powder in Service or Action, it is to be referred to the Gunners Discretion; and here I will give you Tables, whereby the Gunner may give Powder to Taper-bored Ordnance, either for Proof or Action, or any hot Service, from 1 to Ball to 36 to Ball.

#### CHAP. XXI.

A S formerly I have shown, all Ordnance are not true-bored; therefore I suppose it will be necessary for the Young Gunner to know how to give Taper-bored Guns their Powder; and though they are not ordinarily in these Countries, yet it may happen sometime the Gunner may be ordered to make use of such. In my Judgment there are no Guns more sit to go in the Head of Regiments in an Army than Taper-bored Guns are: I mean not Leather Guns, by which the King and Country hath been cheated, but such as they make in Holland of Brass, Cast Ordnance. Neither do I mean those Taper'd Guns, with which the Hollanders cheat the World, being Plates of Brass within and without, betwirt the Skins there are Bars and Hoops of Iron.

# A Table of Powder for Taper-bored Ordnance, both for Proof, Action and Scorm; from 1 pound Iron Ball, to 36 pound.

Iron Ball.	Proof.	rod odrati	Action.				Storm,		
th	15 on. dr.	od odkoj g	抽	on.	dr.	Park to me	15	on.	dr.
3 3	00 05 0	Made and	00	01	90	H. Mart - mi E	00	The Paris	00
o Statu	00 10 11		90	80	.00	Macro no be	1 00	03	00
3	01 05 00		00	12	00	Carlotte Talent Carlotte	00	09	3)
	of 10 II		OI	.00	00	he and pur	00	12	00
3	02 00 00	<b>美国教徒</b> 广泛	10	04	00	-Burn and	00	15	90
77	02 05 05	A Medicional	01			to senten ente	1.0	- 02	00
. 8	02 10 11	A South Claus	02	13	00		10	05	00
9	03 CO 0a		02	04	00	A PROPER OF	QI.	08	00
10	03 05 05	3,190-131	02.	08	00	this usual s	10	II	90
N 11	10 11	set syed the	02	12	00	Part Toward	02	14 CL	00
33	04 00 00	March Language	03	00	00	is food as an in	102	04	90
13	04 05 05		03	04	00-	Control Total Care	02	.07	
14	04 10 11	7 - A THE	03	08	00	Attal Lin Tre	02	1,10	00
15	05 00 00	d extract th	93	12	00	a nestrual 3	02	13	00
17	05 05 05	EVEN A STATE OF	04	co	00.	in the main and	03	co	00
18	06 00 00		.04	08	00		03.	03	00
19	06 05 05	Action to the same of the same of		Land St. Co.	00		03	06	00
20	06 10 11		04	13	00		03	09-	00
a. 21	07 00 00	the water water	os	04	00	12	03	12	00
22	07 05 05		05	08	00		03	15	00
23	07 10 II	Control of the Contro	os	32	00	Alter Children	04 -	02	00
24	08 . 00 00	MI NEST 103	66	00	00	CANTE CAST CON	-04	08	00
25	108 OS 05	allock of sal	06	<b>64</b>	00	off a modernia	04	O Pi	00
26	c8 10 II	re not become	06	08	. 00	The second of	04	14	00
27	09 05 00		06	12	00	ATT 中国 14 11 11 11 11 11 11 11 11 11 11 11 11	os	10	00
29	09 05 05	101 - 0031	97-	OO	00	Popular, in	os	01	00
30.	10 CO 00	antiplacing	97	04	CO	on both a spri	05	97	00
13 Tay 4	10 05 05	Carrier Time Tree	07	08	00	cath all as also	05	10	90
1 32	10 10 11	nto see to	07	12	0)	. 1	05	13	00
. 33	00 00 11	A STATE OF THE STA	08	04	00	ALTERNATION OF THE	06	00	00
34	II of of	FAMBLE SELF	08	08	00	Control of the	06	03	.00
35	11 010 1110	to to all s	0.5	12	00	1 A Same	c6	05	00
36	12 00 00	ol. of	09	00	00		06	1/2	00

In this Table is four Columns, in the first, under Iron Ball is the Weight of the Ball that these Guns ordinarily shoot; in the second, under Proof, is the Weight of Powder for Proof; in the third, under Action, is the Weight of Powder for Action; and in the sourth Column, under Storin, is the Powder for Service. The right order of all Gun-Founders is, That for every 6 to Ball the Powder shoots, they allow 1 to for the Wind.

CHAP.

CHAP. XXII. To find the Diameter and Length of the Taper'd Chamber of a Peece.

Rovide a Tamken to the bore or heighth of the Moft necessary. Ball; put it on the end of an Half-Pike, and put it up till it stop at the Chamber or top; take that out again, having before marked the Half-Pike; then put up the Half-Pike in the Gun to the breech, and mark the Half-Pike again; then take a piece of bowed Wire, and put it in at the Touch-hole to the lower part of the Chamber, and mark the Wire above the Gun; then hale it up till it hack at the upper part of the Chamber, and mark the Wire there again; so measuring betwirt these two Marks of the Wire. you have the small end of the Taper-bore; then measuring the Diameter of the Tamken, and so you have the great End: Then taking the Distance between the marks of the Half-Pike, so having both Diameters and Length, (if you will) you may draw the form of a Taper'd Chamber on Paper, and extract the Wind from it, for the Cartrage going up with more eafe.

#### CHAP. XXIII. For Chamber-bored Guns:

These Guns are tryed with a part of their Balls weight of Powder; So that a Peece shooting 24 lb Ball, is proved with 6 lb Powder: For Ordinary, there is allowed for every pound of Ball 3 ounces of Powder, so that there needs no Table to those Ordnance, for there is not many of those to be found but Mortar-peeces.

But certainly those Peeces must be ancient since their Foundation; That Josephus in his Antiquities of the Jews doth say, That there were Stones shot into Jerusalem, at the Siege, of great weight; that at one time one of these Stones shot off the Head of a Man, and carried it several Furlongs from the Body.

As I am here to speak of Chamber-bored Ordnance, so I do remember that in *Holland* they use to bore their Guns of 6 lb Ball to 8 lb, and that there may come of these Guns to be made use of.

Now know that of Chamber-bored Guns, there are three forts; to wit, First, Those that shoot Iron-ball; Secondly, Those that shoot Stone-ball; And Thirdly, Those that shoot Granadoes and First works.

First, Know that it is a Chamber-bored Peece which hath two

right and true Bores; the one is the vacant Cylinder, all from the Muzzle till you come to the Charged-Cylinder; the Charged Cylinder is from the Touch-hole to the great Bore, called the Cham-

ber, because it is not so great a Bore as the other.

But if this Chamber be too long and narrow, or small, to continue Powder for this fort of Peeces, then the Ball may be delivered before all the Powder be fired, and do little Execution; For it is without Controversie, that the vehemency of any Ball struck from a Peece, is by virtue of the Powder fired in the Peece before it come out, and is rather hindred than surthered by any Powder that is fired after it is out. Likewise there be Chambers short and wide, which may be harmful; for the Powder all string suddenly, before it loose the Ball, the strength thereof many times doth burst the Peece; Therefore it is best in this, as in all other cases, a true proportion be kept.

CHAP. XXIV. To know the true proportion of the Chambers of Ordnance.

A ND first of them which shoot Iron Ball; a well proportion a Chamber for a Peece that shooteth Iron Ball, ought to be three Diameters of the great Bore long in the Chamber, and three quarters of the Diameter of the Ball, the Diameter of the Chamber: Having this proportion, they ought to have one pound Powder for every three pound of Ball for Proof; and for Action three quarters of a pound; this being so plain, it needs no Tables.

The true Proportion of a Chamber in a Chamber-bored Peece that shooteth Stone, is once and a half the Diameter of the Ball long, and the Diameter of the Chamber is two third parts of the Diameter of the Ball: having this proportion, one pound of Powder will serve to prove a Peece that shooteth 4 pound of Ball, and three

quarters of a pound for Action, the Ball being Stone.

Now I suppose, and I hope that I need not doubt, but hitherto there is enough written and declared to the use of great Ordnance of most forts that are used, and how with caution they ought to be handled.

And because I in my Youth have served for a Gunner both by Sea and Land, not doubting that any need Instruction that are undertakers to be Gunners, (but as aforesaid) it may be some Friends may prefer some Young Men before they be capable, even to be Gunners of good Ships, who never knew how to shoot a Gun in anger.

CHAP. XXV. Therefore I will here give some needful Observations

for Gunners of Ships.

1. THE first is, That the careful Gunner coming into a new Ship, diligently and carefully measure his Guns, to know whether they, or any of them, be full Fortified, Reinforced, or lessened in Metal.

2. Then he shall with a Ladle and Sponge draw and make clean all his Guns within, that there remain not any old Powder, Stones, Iron.

or any other thing that may do harm.

3. That he shall search all his Guns within, to know if they be Taper'd, Chamber'd, or true-Bored, or whether they be crack'd, slaw'd, or Honey comb'd within: And finding what Ball she shoots, to make the Weight of the Ball above the Port; that thereby he may fer the same Mark or Number upon the Cartrage and Case, that in time of Service, those who bring the Powder may not go wrong.

4. The Guns being dimensioned and clean as aforesaid; the Gunner shall take half a Ladle of Powder for every Gun, and blow them off, Sponge them well; and finding them clean, Load then the Peece or Guns with their respective Cartrages and Powder; which being rammed home, with a strait Wad after it, then let the Ball roll home to the Wad, and set a Wad close home to the Ball, that the Ball roll not out with the tumbling of the Ship; then must be Tamken that Peece at the Muzzle or Bore, with a Wooden Tamken, which he must Tallow with hard Tallow round about for preserving the Powder from Water; Likewise make a little Tapon of Ockamfor the Touch-hole, which must be tallowed also for Water, before the Leaden Apron be put over; then make your Peece sast as occasion best presents.

5. The Peece loaded and fast, then the Gunner is to have to every Peece 24 Cartrages, at least, ready made; to wit, 12 filled, and 12 empty in fort; Likewise he must be careful, so long as the Gunner's Crew are busic with the Powder, that there be no burning Match or other Fire in the Ship; also to lay his Cartrages in Barrels or Chests in fort, that when there is occasion to be brought, it be without abuse.

Most needful, for great burt may come by a Ball too high.

Most needful, for great burt may come by a Ball too high.

Ball too high.

Also he ought to make the Bags for Hail, for the Guns above, ready benime, and fill them with Stones, Small Shot, or pieces of old Iron, which

may do great damage to the Enemies Men.

AL There of good ships, who never knew how to thoot a Gun in anger.

7. If it fall out that any new Ports must be cut out in the Ship, the Gunner must be careful that they be above a Beam, or close by if possible; also that they be not higher or lower than the Ports before. Likewise that there be room for the Guns to play, because if one Gun should be dismounted, there might be another brought to her place: And observe, that the Carriage standing on her Truckes, the uppermost part of the Carriage must come to stand in the middle of the Port up and down, that a Man may lay his Peece as he pleaseth.

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8. The Gunner must be careful that the Powder in the Room be well covered with Hides; also that the Axtrees of the Truckes be well smeer'd with Sope; also that his Ropes, Rammers, and Sponges be ready at hand; and he must not let the Powder lie unturned above one Month, otherwise the Salt-Petre will descend to the lower part of the Barrel, which is to be gledled.

These me to be megledled.

And he must every Month draw the Ordnance, if he fear they have got any Wet or Moss to the Powder, also for fear of the Salt-Petre dissolving, which may prejudice the Peece. And he must be careful of the Candle and Fire about the Gun-Room and Powder-Room, that there come no disaster. Likewise he must keep a good Account of all Materials that belong to the Guns, as Ball, Match, and Powder, what part thereof he spends, and also what now remains, that

he may give a good account what is become of them.

9. A Gunner must use all diligence before he rencounter with his Enemy, to fet a Balley of Water betwixt every two Guns, that when they fee conveniency, they may dip the Sponges for cooling of the Peeces, and fear of Fire remaining, which may do hurt: And that he be careful not to shoot except he hit, for it is sure, when the Enemy fees that he is not hurt, it gives him more courage: But to encourage Young Gunners, I will counsel them at Sea, not to use a Lont-Staff in Service, but first observing the way of both Ships, whether the one heave and the other fet, or both heave and fet together; and also the sailing of the Ships, if both one way, or on several Tacks, whereby he shoot not in vain: Now if the Gunner have a small piece of light Match, he standing at the left side of the Peece, shall fet his right foot in the Carriage, looking over the Peece, and according as he fees occasion give fire, and at the fire giving, retire his right foot, and before the Peece be recoiling the Gunner is free and by trying his Dexterity will make a good Experiment, and that he will do good Service: But if the Ball have not done to your expectation, you may help the next; for when you fee from the Breech of your Peece to the Muzzle, and so to the Mark, you have a light of three things; fo Euclide avers, that feeing over any three things, you have a right Line from the first to the third, through the second; for there is no Man dare promise to make a good shot at Sea, if he have no experience of the Peece, and observation of the Ship's motion.

10. Also the Gunner must be sure that there be no melted Stuff for Fire-Works done in the Ship but on Shore, for it is dangerous for a Gunner, and great hazard for Ship and Goods, yea and Mens-Lives: Likewise there may no Fire-Work be brought above in the Round-House or Cabin to stand, for fear of shot, but must be kept below till time of need, either in the Powder-Room, or Steward-Room: By the hazard of such things there hath been many and cruel Examples.

Of Mecessaries that a Sea-Gunner ought to have for his Ordnance.

Necessaries that a Gunner ought to have for his Ordnance are many, and the quantity is according to the quantity and quality of his Guns; and also if he be in a Man of War, or a Merchant-Man, then there is difference of Provisions, only I will here name them, let every Gunner take what he thinks will fit, and at the Voyage end give an account what is spent, and what he hath, and how he spent that which is gone.

Powder. Round-Shot in fort. Double-heads in fort. Gut Iron of foot, or foot and half long. Wooden Tampkens in fort. Carrrage-

Paper. Thread, Needles, Twine and Starch.

Match. Mallers, Hand-Spoakes, Rammerheads, Worms, Ladles. Sponge-heads, and
Staves to place them on. Beds and Coins in

fort. Old Strouds for Breeching, and twice laid Stuff for Tackles. Lashers, double and single Blocks, new Rope for Double Tackles, some old Strouds for Sponges, some Lines. Marline, tarred Twine, Port-Ropes. Moulds for Cartrages in sort, Axel-Trees and Truckes. Budg-Barrels, and Lint-Spindles, Crows, Splice-Irons. Primes, Staples and Rings, Tackle-Books, Nails. Thimbles, Port-Bands, Sheet-Lead, and Lead-Shot. Old Canvas, Scales and Weights in sort. Lanthorns, Dark Lanthorns, Powder-Measures. Sope, Horns, and Prime-Irons, Height-board. Height-ruler and Compasses.

With what other Instruments he finds needful.

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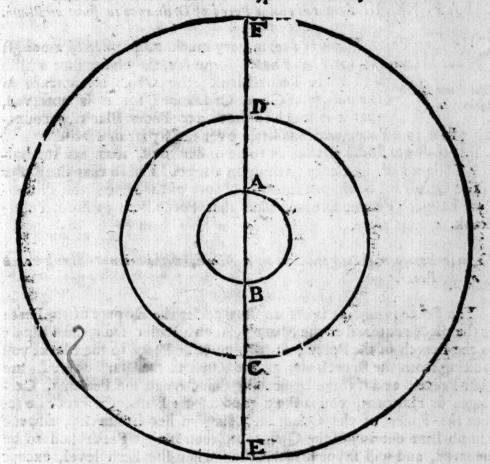
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A N easie way to Dispart a Peece of Ordmance. First, Take the Diameter of the Peece upon the thickest part at the Breech with a pair of Callabassar Compasses, and likewise at the Muzzle at the thickest part thereof; then draw upon a Paper or Board both Diameters: So laying a Ruler through the Centre, draw the Diameter, and then you may the easier take the Dissertence betwirt them.

Example. The Diameter of the Breech (in the preceding Figure) is EF, the Diameter at the Muzzle CD, and the Diameter of the Bore AB; so you see the Difference betwixt the two Circles is DF or EC, which part a Peece of Ordisthe true Dispart of that Reece. If you take a piece of Wax, or Straw, or Stick, of the length DF, and set on the Muzzle at D, you have a true Dispart: I have made them of Iron and screwed them on.

CHAP.

CHAP. XXVII. How to level a Peece of Ordnance to Shoot at Blank.

SHooting Point-Blank is a term very much misconstrued amongst our Gunners; for I have heard some say, they have shot a Mile and more Point-Blank; the which is contrary to the nature of Great Ordnance; for it is observed, that it is much to shoot 350 Paces Blank, account-

But to shoot Point Blank, is to be understood, that then the hollow Cylinder of the Peece lieth upon a level Line, so that the Ruler of the Quadrant being put into the Mouth of the Peece, the Plumb-Line hangeth Perpendicular, then that Peece lieth to shoot Point-

Blank.

To know how to make a good Shot at a Mark, within Point-Blank-reach of the Peece.

The Peece lying, as is before shown, set the Dispart of the Peece at the place required on the Muzzle, then a Ruler from the Dispart to the Breech of the Peece; so turning your Peece to the Mark, you looking from the Breech alongst the Ruler to the Mark desired, fire your Peece; and if there be nothing desective in the Peece, or Carriage, or Platform, you make a good shot: But if the Peece lie so, that the Ruler of the Quadrant being in her Concavity, and the Plumb-Line cut any of the Quadrant, then is that Peece said to be elevated, and will shoot surther than when she lieth level, except there be some Object which lieth higher than the Peece to stop it. And if that Peece lie so, that when the Ruler of the Quadrant is in her, the Plumb-Line hang without the Line of Level, then that Peece is said to lie under Metal, and will not shoot so far as if the Peece were lying level, except there be a very great descent under the Peece.

Moreover it is certain, if Men have time, and the Object lying within Point-Blank-reach of the Peece, that the industrious Gunner observing these Rules, may do good Service at the first or second Shot: for it is certain, that if a Man look along any three things or marks on one Line, then betwint the first and third there is a right Line over the second; so that if a Man look from the Breech of a Peece, over the end of his Dispart on the Muzzle of the Peece, and to the Mark he is to shoot at, then the Breech of that Peece and that

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Mark lieth on a right Line through the Dispart: Therefore it is imagined, the Mark being within Blank-Reach of the Peece, if the Peece be loaded and fired she will make a goodshoot, all impediments being removed.

## CHAP. XXVIII.

If the Ball err, contrary to your expectation, either above the Mark or below, or on either fide, follow the Rules following to help the next.

Rule 1. If the Shot err too high or too low, help it thus:

When you have done as is described, and that the Shot hath carried too high as in D, or too low as in E, the Mark you shoot at being in C; having loaded your Peece, you are to find the middle of the Bore of the Peece, and the places on the Base-Ring and Muzzle-Ring corresponding, then you are to set the Dispart, so you cause traverse your Peece till you bring the Breech of the Peece A to the top of the Dispart at the Muzzle B, and the Mark C in a Line; after Fire given, you hold this for a Rule.

But the Gunner may lay his Peece very artificially, and yet the Shot may carry contrary to expectation several ways; if it be too high as in D, help it thus: having laid your Peece as at first, in the Line ABC, and found the Ball in D; then lengthen your Dispart on the Muzzle-Ring, till looking over the Peece you find ABD; this done, you are to cause lift the Breech of your Peece, till over your Peece and Dispart you find the appointed Mark C; then fire, and you will hit your defired Mark.

Likewise if your Shot at first had been below the Mark, as in E; you are to load her, and bring her to her first station; observe the capand then you are to take from your Dispart so much, per Peece, No. 1. till you have the Line ABE; this done, you are to lower the Metal of your Peece, till you find your desired Mark.

ABC; fire your Peece and you do good fervice.

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Now if the Ball should come to light on either side of the Mark, (as in the second Figure of the Copper-Peece) in E to the right hand; to help the next, lay your Peece in all points as before, with her Dispart; then you are to go to the Breech of your Peece, and find at your conveniency a place, on the Base-Ring, looking over the Dispart:

Dispart, you see the mark of the shot at E; mark narrowly that place of the Base-Ring, (with Chalk, or what you please) keeping that Mark to look over your Peece, then you cause traverse your Peece, till looking over your Mark on the Breech, your Dispart, and behold C your desired Mark in a Line; fire that Peece, and you have your desire. And if to the left hand, you may help in the same manner.

But if you were to shoot at any known distance, without the Blank-reach of the Peece, upon any degree of Random, first meafure the distance to the Object, and as you find it in proportion to the Blank-reach of the Peece, the same quantity you may take from the Dispart. For if your distance be + farther than the Blank-reach of the Peece, then take from the Dispart & Observe the figure in the part of its length; by holding this propor-Copper Peece, No. 2. tion, if the Object be on a right Line from you, you will do good fervice. Many times it falls out, that when a Gunner enters a Battery, Gastle, or other Fortification; before he can have time to observe Rules, orders are given to fire some Ordnance; it may be in all his Life he hath not feen the like before that time, therefore he mult lay his Peece by the discretion of his Eye and former experience; if then his Ball strike the Mark, his Experience and Discretion is a good Rule; but if the Ball go besides expectation, you may help as is before taught. For if the Gunner observe these Rules cautiously, he shall find both pleasure and profit, and have praise of the Spectators.

CHAP. XXIX. The way to Shoot a Ball from a Hill to a Valley, or from a Valley to a Hill.

Any and divers Opinions are there of shooting from Height to Valleys, as Nicholas Tartaglia affirmeth, That though the Mark be within Blank-reach of a Peece, the Ball shot under Metal will strike above the Mark aimed at. Likewise one William Class, in his Book called the Prastick Busketrie affirmeth the same by many Instances, That a Ball shot from a Height will over-shoot the Mark, though there be no impediment. But I cannot blame the Hollander, in regard his Country is very plain, and no remarkable Height, whereby he might have confirmed what he saith by practice. But I rather adhere to Luigui Callado; he informs, That a Ball being shot from a Height, will strike below the Mark, as I my self by practice have found divers times.

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For in the Year 1650, I was in the Castle of Edinburgh, when that Army of Rebels to our King did beleaguer that Castle, to that many times I had occasion to shoot so far under Metal, for below the Level-Range, that I have been forced to cut the brest-band of the Carriage quite out, and so to elevate the breech of the Peece, that it hath been supposed she would fall over the Wall; and tho in this case I durst not coin my Peece with fast Bed and Coin, yet always I found the Ball to hit below the Mark till I helped it.

One remarkable Instance I had of this, in shooting at that Wirror of his Time for Loyalty and Gallantry, James Marquels of Montrofs his Head, standing on the Pinacle of the Tolbooth of Edinburgh, with which the Enemy reproach us, a counting Loyalty a Sin worthy of Death. Now at this time I was by the Governour commanded, that there should not a Gun be shot in the Castle which I took as an ill Omen of what followed; I demanded a Read fon for it: He told me I had too much Blood on my Head already: I being somewhat troubled, lest His Majesty, and those that loved Him, both Abroad and in the Castle, should suppose me a Helper to the Treachery, defined the Governour to give me Orders in presence of all the Souldiers, otherwise I would not dealt. So he fent for me, and on the Head of the Parade, commanded me that no Ordnance should be shor in the Castle; for if any Gunner should do it. I should suffer a Council of War: Nevertheless, being curious to have down the Head, owhich deferved Honour above what I can write, I laid a Peece of 24 th Balli, and because I durft nor be accessary to any Acting, far less to that, I defined Thomas Knible. who was Keeper of the Magazine, that he should fire that Peece. after he faw the Governour and I gone to walk; which he did. The Governour hearing a Shot, and I in his Company, inquired who had shot that Gun: I answered, I knew not: So that one returned to the Wall to know who it was, and whereat he shot; the young Man answered, Sir, I thought that it was fin in you and the Master Gunner to fuffer these Men to fortify themselves, and raise Batteries before your Noie, and you not ftop them, wherefore I shot at this, meaning the Battery.

But that Providence had ordered that Head to be taken down with more Honour, I admired of its abiding, for the Ball took the Stone joining to the Stone whereon it stood; which Stone fell down, and killed a Drummer, and a Souldier or two, on their March betwing the Lucken-booths and the Church, and the Head remained,

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this being by the allowed neglected on before the at which will well that Army of Rebels to our King did the out saw es month and

New any that knows the place, knoweth that betwist the Fore-Wall of the Castle and the Tolbooth is not a quarter of a Mile: so that it was in blank-reach of a Demi-Cannon were the Peece lying higher than the Mark shot at, shot lower than the Mark. And I am of Opinion, that Reason must give it to be so, in regard that the parallel dime made betwint the Breech and the Dispart, say 8 Inches near above the bore of the Peece; and if it carried about so sar below the Mark, I am sure she perfected the Line, the bore made parallel to the Imaginary Line above. So much for shooting from a Heighth to a Valley, which may be helped, by laying your Peece so as your Imaginary Line parallel to the bore, direct you half a foot above the Mark, then you shall do good Service. See the Figure A.C.

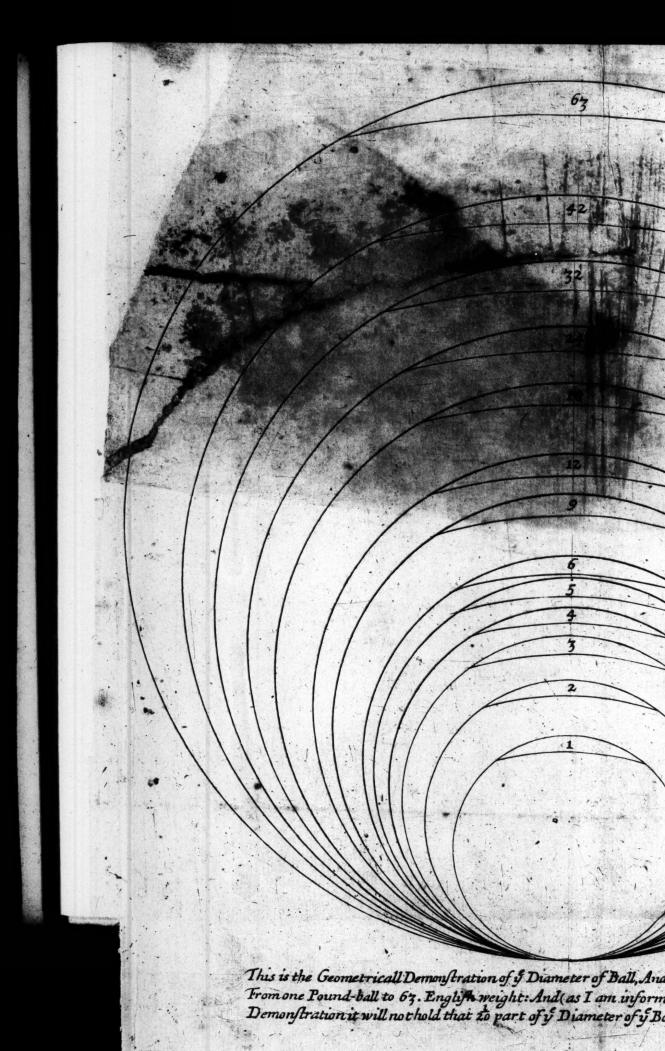
It is also to be observed, that shooting from a Valley to a Heighth, that a Ball will over-shoot the Mark, if it lie within point-blank-reach of the Peece: Reason should give it so: for the Peece being clevated to a great Heighth, the Ball with the force and exaltation of the Powder, doth elevate above the true Line, which the bore maketh to the Mark, in regard of the Wind or Vacancy that is betwize the Ball and the Peece: As was found by shooting at the Castle of Edinburgh, where the Gunners shooting to dismount our Ordnance, most of their Shot slew over the whole Castle, till observed by the Gunners and helped. But when we come to treat of Opservations of Heighths, Depths, and Distances, by the Quadrant, you will have further satisfaction.

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CHAP. XXX. To know how to make as good a Shot by Night as by Day.

Sthere is none will deny, that among the many Terrifications which may be put upon an
aid a sold le Enemy, to shoot amongst them by Night is not one
of the least of them: but if you will shoot by Night, you must
provide by Day, and observe as followeth.

being loaded with Powder and Shot, as if you were to make pre-Good Objervations if Mariners Compais, and fet that on the breech of the Peece, and looking over the Peece you fee the Mark.





rof Ball, And y Diameter of y Bores of Ordinance I am informed) commonly used in England by which meter of y Bore is Sofficien wind for all Guns.

Mark, and observe how the place bears off you, so that in the Night you may know how, and on what Point of the Compass the place bears off you, when you are to give Fire; then take a Line and Plummet at the Muzzle of the Peece, and right over the middle of the Muzzle let the Plummet hang to the Platform; so you find memark, or make a mark on the Line where it cutteth with the lower edge of the bore of the Peece at the Muzzle, and likewise remark where the Plummet southeth the Platform: And for your more affurance, you may let the Peece be fired in the Day-time at the same Mark; and as you find that Shot to profecute, you may proceed as is before earght, and in the Night you may do good Servicesm work work.

Compain, catting your Matrofs of Pioneer to trade Man a by verse the Peece to your defire; then go to the Muzzle with your Plumb Line; cathing them to elevate or abase the Metal, till you find the Plumb Line and Plumb fall in their former Stations: So in firing that Peece you may do good Service by Night or by Day.

But withal you must observe the distance to the Wark, if you be to thoot beyond Blank reach of the Peece, also how the Wind is whether with or against you, or on which side, for by these means the Ball may change her Course; and so if you have a dark Lanthorn, that you may see your Compass and Plumb-Line, observing all these things, you may shoot by Night as well as by Day.

. Ton to the Night to the read hot with the Night by not to not added

Is shall be requisite to take some Butter or Tal. To be sure you will low, and melt them in some Kettle, wherein you seember you Ball that is to be shot, and roll the sight. Same Ball in the Powder, that the Powder may flick fast to it; and when you have done, but shome the Powder in your Peece; and observe you put no Wad betweet the Powder and the Ball; so when you give fire, the Ball will slame as a Candle; and where the Ball doth light, the mixture will sly on the Object, by the light whereof you will see whether you have hit the Object or not.

CHAP. XXXI. To know how far any Pages will Shoot at any degree of Random.

This Task is so difficult as there are proportions of Ordnance, yea it will alter by the alteration of Weather; likewise if the place lie higher, the Peece shall shoot farther over a Valley at the same Random, than she shall from a Valley to a Heighth; for these Reasons, I have found none that ever made Tables for great Ordnance, that would or could make them good on all Accounts and all Degrees. 'Tis uncertain to find exact Truth in random Tables.

Now the only Rule by which a Gunner may know how many Paces his Peece will shoot, in elevating from Degree to Degree, is to take good Notice how far she shoots Point-blank, as also Horizontal with the Metal; which Distance being marked to be a part, or a half, or a parts farther than Point blank, than hath he a convenient proportion to work by, and to find his defire reasonably near.

Example. There is a Demi-Cannon floots Point-blank 200 Geometrical Paces, and Horizontal with the Metal 400 paces, this holds proportion as 2 to 1, the one half less: Therefore say by the Rule of Three, As 2 is to 1, to is 200 to 100 paces, that this Peece shoots farther at every Degrees elevation: Yet not wholly through the Table, for there is a rebating in every Degrees elevation: Now to find this, you shall yet divide 100 by 44, and you have 2 vi : So as 3 times 11 is 33, and 11 is 44; therefore when you defire to make this Table, take 2 from 100 there remains 98, which added to 200 makes 298; then take 2 from 98, and there remains 96. which being added to 298, giveth 394: This is the first and second Degree elevated; this continues till 35 Degrees elevation, where you have 44; and you have for 35 Degrees elevation 2400 paces; then the addition is 28, and the rebate of every Degrae 3; by which you may make this Table following: and in doing to with all others you have your defire. tou give fire, the Ball will fame

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This is now a brief way of making a Table of Randoms for a Demi-Cannon, which may be done in like manner for any Peece of Ordnance whatfoever; first knowing the true Distance the shoots at Point-blank, and the Distance she shoots lying Horizontal by the rucy such nover and work as defore, some parties and work as less the Difference Rught Shadow : And show that if the Line fall on 100, the Difference

- As this Table is for a Demi-Cannon, so there must be one for every fort of Ordnance the Gunner makes ufe of And he shall then is the Dinance | parts of the Heightn; if charabanhylbrad half of the Heighth if on 32 f pairts, one that pair of the

CHAP. XXXII. The Geometrical Quadrant, with the Ufes in Menfor a Gumer. Heighths, and Depths, and Diffunces whoft neful to the Place oblewed, is more than the Heighth of the

COUNTRY OF THE CHARLES ON MUCE

s. To measure the Heighth of any Tower, Wall, or Castle, or any other Body, standing on a Plane, if you have access to it, by the Gunter's Quadrant. Example, Suppole the Thread to fall on 24 parts of Theora P

ETo the Ruler of the Quadrant for to your Eye, that you fee through the Sights, from the place where you stand, the mark YOU

1941 A. Light to the Art of Gunnery.

You defire to observe; then note what part of Umbra Retta, or Versa, your Thread curs, and you shall find the Height in this manner.

1. If the Thread of the Plummet fall on 100, then is the Heighth defired equal to the Distance between the Observers foot, and the

Ground or Root of the thing observed!

Conclusions and Ob. Observers foot and the ground of the thing observed the Quadrant.

Occording as the certs of Bight Stadow, when it is the distance betwint the fervations done by Observers foot and the ground of the thing observed the Quadrant.

Thread is to too: Therefore use the Rule of Proportion, other-wise called the Rule of Three, and set the parts of Right Shadow in the first place, cut by the Thread or Plummet Line, and the 100 in the second, and the Distance you are from the Root, or foot of the Mark, in the third, and the sourch place will show the desired Heighth; as you may see in the Example following.

Example. Suppose the Thread to fall on 25 parts of Umbra Retta, and the distance between your Foot and the Wall be 30 foot: Then say, as 25 parts of Right Shadow is to 100; to is 30 foot the distance given, 191720 foot the Heighth required 1940; which you must add the length between the Observers Eye and the Ground.

3. But if the Gunner capper cipher, then do this; Go fo far back or forward, till you fee the Mark defined, and that the Plummer of Line, of your Quadrant (being still observing) fall on the parts of Right Shadow: And know that if the Line fall on 100, the Distance is equal to the Heighth: If the Line fall on 100, the Distance france is three quarters of the Heighth; if it fall on 664 parts of then is the Distance 3 parts of the Heighth; if on 50 parts then half of the Heighth: if on 33 3 parts, one third part of the Heighth; and if on 25 parts, one quarter of the Heighth: by which you may conclude the Heighth of what you observe the Heighth of the Heighth of what you observe the Heighth of the Heighth of what you observe the Heighth of the Heighth of what you observe the Heighth of the Hei

or Contrary Shadow, then know that the distance of the Ground to the Place observed, is more than the Heighth of the same: And the proportion is as 100 parts is more than the parts cut off the Contrary Shadow: so is the Distance from the Mark, unto the Heighth of the thing observed.

Example. Suppose the Thread to fall on 25 parts of Umbra Verla, and the Distance betwinto your Footsand the Wallube spools of Then say: As 100 parts is to 25 parts of Contrary Shindows is to

300 foot the Distance given, to 75 foot the Heighth required. To which if you add the Distance between the Observers Eye and the Ground, you shall have the true Heighth.

And if you cannot Cipher, then go so far backward or forward, always seeing the Mark desired, till the Thread sall on what parts of Contrary Shadow you would have it; and if it be 100, then is the Distance and Heighth equal; if it sall on 75 parts, then is the Distance one quarter more than the Heighth; if it sall on 66% parts, then is the Distance one third part more than the Heighth; if the Thread sall on 50, then is the Distance one half more than the Heighth; if it sall on 33 \frac{1}{2}, then is the Distance is more than the Heighth; if on 25, then is the Distance three quarters more than the Heighth; if on 25, then is the Distance three quarters more than the Heighth; Ever adding the length from your Eye to your foot, then you shall certainly have the true Height.

o. This manner is used to measure the Height of any thing whereto you may have access: If it were that you must measure the
Height of a Wall, or any other thing standing on the side of a River, then you must have two Observations, in manner following:
First, Measure the distance from your Station to the side of the River; being come to the brim of the Water, stand perpendicularly
upright, draw down the brim of your Hat before your Face, till
you looking by the brim of your Hat, see the Foot or Root of the
place you would measure; then turn your self about, observing in
all things your Gesture, till you see on that side of the River where
you stand, some Hill, Down, House, or any other Mark; thus you
shall measure with your foot the distance to it, and then work as is

2. To measure the Height of any thing standing on a Plane from you, when you can have no access to it, br were hindred by the Enemy to come near it.

the length of the Hypotensiel Line A B. to b

before flown.

t. To this Work you must have two several Observations, as followeth: Put the Ruler of the Quadrant to your Eye, in such manner, that through the Sights you see the Mark desired; take notice then what parts of Contrary. To know how for or Right Shadow is cut by the Thread or Plumor what Distance you met-Line, and then where you stand for up a Staff; then you are to go a remarkable distance most neversary for a backward or forward, and take there your second Gunner.

Station; and observe your Mark as before; then

note well what parts of Contrary or Right Shadow your Line cuteth; note that also down: Now if it be so, that in both your Stations the Plummet-Line hath fallen on parts of Right Shadow, then deduce the lesser from the greater, and keep the Difference: Then say by the Rule of Three, As the Difference in the parts of Umbra Resta, is to 100 parts in the Quadrant; So is the Distance between the two Stations to the desired Height of that Body: But it is to be understood, that you must not forget to add the Height of your Eye from the Ground.

Example. In the first place, when you find the Thread fall in 25 parts of the Right Shadow, and in the second on 50; then let the

distance betwint the stations be 30 foot.

Say then by the Rule of Three; As 25, the difference of the parts of Observation, is to 100 parts of the Quadrant; So is 30 foot the distance of the Stations, to 120 foot the Height required; to which add the Height of your Eye.

2. But if at one Station (or possibly at both Stations) the Thread falls on parts of Contrary Shadow, then the parts must be converted to parts of Right Shadow, as shall be shown in the following

Example.

Example. Suppose there were placed some Guns on the top of a Hill, as in the Figure by A: by which the Gunners in the Valley B have a great deal of loss and trouble; wherefore order is given to one of them, to do his endeavour to dismount these Peeces at A: Now to do this with understanding, and what haste convenient; First, He must know the height of the Hill AD, with the distance BD: Then he may by Prop. 47. of the first Book of Euclide, find the length of the Hypotenuial Line AB; to be assured how many degrees of the Quadrant his Peece must be elevated to the Mark.

We say that the first Station observed, the Thread Take for Ex- fell on 25 parts of Contrary Shadow, and at the seample. cond on 90 parts of Right Shadow; then you cannot

take 90 parts from 25 parts; therefore you must alter the 25 parts of Contrary Shadow to parts of Right Shadow, in inanner following: Multiply 100, the one side of the Quadrant by it self, and you have 10000; this you divide by 25 the parts of Contrary Shadow, and you have in the Quotient 400 parts of Right Shadow, which is equal to 25 parts of Contrary Shadow; then take 95 pasts from 400 parts, there remain 310 for the Difference: Also let the Distance betwint the two Stations, from B to C, be 200 foot: Then say by the Rule of Three; As 310 is to 100 parts

in the Quadrant; So is 200 foot the Distance of the Stations, to 64 \frac{1}{3}\frac{1}{5}, which is very near 64 \frac{1}{3}\frac{1}{5} foot, the Height of the Hill A D: We should now shew the way to find the Distance A B and B D; that those who cannot cipher, may understand this.

3. Therefore we will give one Example or two, that they may do such without Arithmetick.

These must search out their Stations, in which the Thread may sall on all such parts of the Right and Contrary Shadow as they defire; which is easie to be done, if they go discreetly forward or backward, and measure the Distance betwixt the Stations, till the Thread sall where they desire.

1. If the Thread fall at the first Station upon 100, and at the second on 50 parts of Right Shadow, then is the Distance half the

Height.

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2. Or if the Thread fall at the first Station upon 100, and at the second on 66 3 of Right Shadow, then is the Distance betwixt your Stations one third part of the desired Height.

3. And if the Thread fall at the first Station on 100, and at the second on 75 of Right Shadow, then is your Distance just one quar-

ter of the defired Height.

4. Likewise if at the first Station the Thread fall on 100, and at the second on 66 3 parts of Contrary Shadow, then is the Distance half the Height.

5. Or if the Thread fall at the first Station on 100, and at the second on 50 parts of Contrary Shadow, then is the Distance equal

to the Height defired.

6. The same it shall be, if at the first Station the Thread fall on 50 parts of Right Shadow, and the second on 66 3 of Contrary Shadow. But still remember to add the Height of your Eye above the Ground.

4. To measure the Distance to any place, or the Breadth and Length of any Plane or Water.

By what hath been said before, it appears plainly that in the meafuring the Height of any thing, there must be once a known Distance, to wit, some length of the Plane whereon the Height is erected: Likewise in measuring any Distances, as the length of a Field, it is very necessary to know the Height of something thereby; which may may be easily done: for if you were to measure the Distance to a Fort, Battery, Trinal, or Bulwark, which you desire to know; if the Distance be not great, in that case you need know no Height but your Eye from the Ground where you stand; But if the Distance you would measure be great, then it is needful to have a known Height to stand upon, which Height you must add to the Height of your Eye, which may be done with a Plumb-Line, whose Marks you

know: Then work as followeth.

Example. Take for Example, that you defire to measure the Distance from B to D; then turn the Center of your Quadrant to your Eye, and observe through both your Sights the Point D; remark well what part of Right or Contrary Shadow the Thread cutteth; If it happen to fall on 100 parts, then ought the Distance to be equal to your Height: But if the Thread fall on parts of Contrary Shadow, which in such Cases is ordinary, then is your desired Length more than your known Height, so much in proportion as 100 is more than the parts cut of Contrary Shadow, which the Line sheweth. Therefore say by the Rule of Three; As the parts of Contrary Shadow, which the Plumb-Line sheweth, is to 100; So is the known Height unto the Distance required.

Example. The Thread cutteth 1 3 parts of Contrary Shadow, and the Height from the Eye to the Ground is five foot: Then work as

followeth, and you will find the length B D to be 375 foot.

Now having the Perpendicular A D, and the Base B D, you may easily find the Hypotenusal A B, to be near 380 foot: But here you are to extract the Square Root, for Euclide in the 47th Prop. of the first Book of his Elements, hath proved by Demonstration, That in Right-Angled Triangles, the Square which is made of the side subtending the Right Angle, is equal to the Squares which are made of the sides containing the Right Angle. Where if two sides be given, we may find the third side thus; in the Right-Angled Triangle ADB,

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you have AD 64 i foot, and you have the Base BD 375 foot; whose Squares being added, and the Square-Root extracted, you shall have the Square-Root near to be 380 i foot for the Hypotenusal AB: For Extracting the Square-Root, it is described in Chap. 6. and 7.

This I have done for the use of Young Gunners, that when occasion may present, they may lay their Peeces at a reasonable Degree, thereby to come near the Mark at the first Shot; And always

may observe a greater distance from a Height to a Valley.

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Example: There is a Castle, as the Figure sheweth, and in the Battery there lies a Peece of Ordnance; If it were desired of the Gunner to know if this Peece might be of service to dismount the Peece in the Battery C: Now the Gunner must desire time to measure the Distance from him to the Battery C; whereby he may the more assuredly Answer.

Then shall he take a Line and measure the Height AB; then standing at A, shall take the Quadrant with the Center to his Eye, and beholding through the Sights the Mark C, Remark narrowly the parts cut by the Plumb-Line, which is without fail parts of the Contrary Shadow: Then say, As the parts of Contrary Shadow are to 100; So is my Height from the low Battery to the Distance required. Let the Height AB be 95 soot, and the parts of Contrary Shadow 54, and you will find the Pacit to be 1809 \$ foot, or 362 Geometrical Paces very near.

But if you please to reduce the Distance to Paces, divide the Quotient by 5, for 5 foot make a Pace, and you have as afore-said.

This is so clear, that I think any Gunner may perceive, that if he in the Battery C, elevate his Peece two Degrees above the Level, that then he might do good Service, and by once firing, if the Ball go beyond expectation, you may help the second.

Necessary Observations for Gunners, either by Sea or Land.

The like may the Gunner in the Battery B do, and also the Gunner in the Battery A to C: and so each to other, for they have double Advantages of the Gunner at Sea, except he be lying in a River; and let his Ship lie never so still, so long as she is a-float, she hathever a Motion, nevertheless the Observant Gunner

in a Ship may do good Service.

For I my felf in the year 1652, or 53, being forced from Scotland, when the War began betwixt the States of Holland, and the (then) State of England; and as many better than I were in necessity, I put my felf in a Frigot of Terveer, one Jacques Wolfes Captain, I served there for a Gunner, and in our Voyage to Shetland to bring home the Hollands East-India Fleet, we met with a Storm, where we lost above 20 Sail of our Fleet, our Ship was called Prince Rupert; but with this Ship we were forced to come to Anchor betwixt Fulla and Shetland, and by providence road the Storm out; when we had fair Weather, we went to Brasa Sound in Shetland, and there riding at Anchor with three Ships of our Pleet: the Commander or Corporal of the Souldiers and I fell at Dispute concerning his Men, that they could not thoot at a Mark; whereupon he told me, That I could not shoot so well with a great Gun, as any of them did with their Musquet; at last I wagered with him that I would shoot as near with a great Gun, as he himself with a Musquet, whereupon we agreed, (the Wager was two Rix Dollars): I fent the Quarter-Master to our Captain, who was aboard one of his Conforts at Dinner, for liberty to shoot; which was granted: The Mark we were to shoot at, was the Buoy of the Anchor of the same Ship our Captain was aboard of; so that we had the four Captains for Judges: I brought a Sacker-Cut, from the breast of the Steerage to the Main Mast; I disparted and loaded her, and set her to the Port, I set her to the middle Port of the Ship; then we were at a Contest who should shoot first; I gave him that priviledge: So after he shot, he found he came not near by three yards, as it was alledged; and that he might be better pleased, I gave him liberry to fhoot again, where he made little mends: Then I laid my Gun to the Port, and observing the ranging of the Ship, I gave fire at my conveniency, and strook the Buoy, which lay about 150 paces from us; there are Men here in London that did fee it. I fay, good Service may be done aboard a Ship, if the Gunner be cautious. And by this I would have you know, that I would have Gunners to consider, that the middle of a Ship is the only place for to make a good

good shot, though by accident there may be some made either afore or after; as I will give an Example.

Example. Suppose there is a Ship in a River or smooth Road a pretty distance off, as this Ship EF: The Gunner is demanded if he could do any good Service with his Guns at the Battery on the Shore G, which only could wrong them. In the Figure, Numb. 133.

This you must consider, could not be answered, till he knew what distance he lay off; therefore he must observe as followeth: First, with a Lead-Line measure the length from your Topmast-Head to the Water, as from E to F; then go to the Topmast-Head in F, and observe with the Center of your Quadrant to the Eye, that through the Sights you see the Battery G, and in all things doing as in the Battery A for clearing. The Peece he is to use here is a Demi-Canhon, which shoots Point-blank 200 Paces.

Example. Let the Height from the Water to the Topmast-Head be 90 foot, the parts cut of Contrary Shadow 5; so set it on the

Rule as followeth.

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1800 foot: Which is 360 Geometrical Paces.

Suppose the Gunner in the Ship had a Demi-Cannon, which shootesth Point-blank 200 Paces; Therefore may the Gunner conclude to elevate his Peece 2 Degrees, and thereby at the first shot be pretty near the Mark; by which he may help the second: Even

fo may the Gunner in the Valley at the Battery G, observe to do good service on the Ship EF: Likewise the Gunner in the Battery A, may do good Service every-where round about, if he observe what is before set down: Nevertheless my desire is to set down another Example of observing by the Cross-Staff.

Example. It is defired to know the Breadth of the Bulwark ABC: First, You are to observe the Distance of the same, as from D to B, which we suppose to be 750 foot: Take the Cross-Staff as EFG, having thus on the end of your Staff a Cross, as FG, at such distance as you may see by the Transom F in C, and G in A; then divide the length of your Staff in as many equal parts as you please:

As here let be 15 parts, and the Crofs F G, we make 7 of the fame parts: Then fay by the Rule of Three, As 15 parts, the length of the Staff, is to 750 foot EB; So is 7 parts, the length of the Crofs, to 350 foot for the Bulwark ABC. Do the like with all others, and give good heed to the following Questions and Answers, which are useful for all Commanders, Captains, or practised Gunners, as

well in Offensive as Defensive Service by Sea or Land.

If a Man were on the top of a Rock or Hill, on the fide of a River, and on the other fide faw a Tree, and would know the diffance over to that Tree, as the Figure C AB: To do this you have two Observations, the one is the Line of Level; then going on a Right Line from A to C, you observe, and find the Thread cut 54 parts of Right Shadow; then measuring your distance AC, and finding it 63 foot, you follow the Ground-Rules, 54 gives 100, what 63 foot Difference of Stations?

CHAP. XXXIII. Questions for the Practice of what bath been formerly taught.

Fort, Castle, or Town, and hath secured his Army by Intrenchments, and hath taken notice of the most sitting places for Approaches: Now the Question is to the Gunner, How near they may approach the place with Batteries, and at what Distance the Cannon will do the best service, that there they may be planted and made.

Answ. If I were to answer, I would defire to approach as near as it were pessible to come, and to plant the Batteries about 100, and

fome 50 foot from one another; and if it were possible even to the Counterscarp; not only thereby to give the place most damage by the Guns, but also to frustrate the Enemy from fallying out, as likewise to do them most prejudice at their Calements, to Guns and Gunners, by which they might be forced not to dare to shew a Head above the Wall.

Quest. 2. This Resolution is good, but very dangerous to perform; for as the Proverb is, It is dangerous to chair a Dog out of his Nest; for if there be a brave Enemy within, how could you approach so near, but it should cost many a brave Souldier his

Life?

Answ. As it is without Controversie, where Carpenters work there must fall Chips; but that will never cool the Courage of a brave generous Spirit, ever considering, where ever we are, we are in the Hand of God; yea, the danger is not in all places alike, for if you be where there is Earth enough to work, there you begin to cast up Trenches and Mounts against the Town to save your selves from harm; for the higher the Earth is, the deeper is the Trench to be made, to save you from the fight of the Enemy.

Quest. 3. When you are approach'd so near the Enemies Strength, that the Cannon is to do service, Whether should you chuse a Bul-

wark or a Curtain, for your storm-place to play upon?

Answ. That must be according to the greatness of the place; if the Bulwarks be of great distance one from the other, in that case I would rather chuse a Bulwark than a Curtain, there to make my Breach, thinking that I should come sooner to my advancement there, because the Bulwark is better fortified than the Curtain, and is a principal Strength: And if you make your Breach for Men to enter, you find them sometimes cut off, so that you may begin to fortifie there anew, where you are as it were in the Enemies Bosom; this occasion you have not in a Curtain. See Capt. Hexham.

Quest. 4. If you did storm this Bulwark, and found there some Guns that before you had not seen the like, and that you must prefently use them against the Enemy, and know not what Ball they shoot: What is the quickest way to find their true Powder and

Ball?

Answ. If the Peece be lest loaded, she must be drawn; for the Enemy in policy might so leave a Peece, on purpose to split about their Ears that take her: When drawn a piece of bowed Wire being put in at the Touch-hole down to the bottom of the Concave, upon the Metal mark that Wire with a Knife; hale the Wire up

till it hack on the upper part of the Metal in the Chamber, and mark as before your Wire; take the distance betwixt the two Marks, and that is the Diameter of the Bore: And fee if it be the Diameter of the Bore at the Muzzle: If you find her a true-bored Peece, then take your Compasses, and extend them to the length betwixt the lower mark and the hack of the Wire; this Extention being taken on the Scale of Powder gives you her Powder; and extending your Compasses betwixt the Marks, lay that to the Height-Rule, and you will have the Height of the Ball : Otherwise finding the Weight of the Ball, refort to the Table of Powder for that Fortification, and where you find her Weight of Ball, you will find the Weight of Powder for that Peece; for having the Diameter of the Bore and one fide Metal, double the one fide Metal, and add the Bore to it, you have the Diameter of the whole Peece: Then fay, As 7 is to 22; So is the Diameter of the Peece to her Circumference: And having one fide Metal at the Breech and Muzzle, you have a Dispart: So presently you may do good Service.

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Quest. 5. When you have the Diameter of the Bore of a Peece, How do you know what Ball will serve that Peece to shoot, and neither be too high, thereby to hurt the Peece; neither too low, to

miscarry by reason of the too much Wind?

Answ. As it is convenient the Ball be something lower than the Bore of the Gun that it serves for; -and some have thought fit to declare one quarter of an Inch to be a sufficient Wind to all Balls; and others have declared, that a twentieth part of the Diameter of the Ball, is a sufficient Wind for all Guns: I hold that quarter of an Inch to be altogether abfurd; because except a Man can give the true Demonstration, as you are taught, and is set forth in pag. 34, to 43. he shall never know how to extract the Wind betwirt the Bore of a Peece and her Ball. For if you please to try for fancy; A Cannon of 8 Inches in the Bore, shall have the Wind for her Ball part of the Diameter; as also a Base of two Inches in the Diameter of the Bore, hath but 1 part of the Diameter of the Bore; for if a Peece of 1 to Ball shall have proportionable to 9 to Ball, she would have no Wind at all; and if a Gun of 63 th Ball had proportionable Wind as a Gun of 9 to Ball, the would have too much by 15 part; behold the Demonstration, Folio 86, and a Peece of 4 Inches in the Bore, hath just 10 part of the Diameter of her Bore, for the Wind to her Ball: which will never stand as a general Rule, except it be Geometrically demonstrated, where you will find the Height of the Cannon-Ball just 11 parts of her Bore, the fmall

small Ball " parts, and the other ": Wherefore I aver, all that hath been writ to this purpose, is but Supposition and no real Rule; but Geometrically you have your desire, and need not to follow any other Rule for extracting the Wind to find the true Ball.

Quest. 6. When you have obtained Geometrically the true Diameter of a Ball to fit a Peece, the Question is, How shall you know

the weight of that Ball, it being Iron?

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al II Answ. Some receive this by a common Opinion, that 4 Inches Diameter of a Cast Iron Ball is 9 th Averdupoise Weight, as you may see by Dr. Weight's Tastimetria; wherefore I say that is the most certain Rule. Now if 4 Inches Diameter weighs 9 to; What shall two Inches weigh? You will find the work stand thus.

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And it is a general Rule; behold you see a Ball of 2 Inches Diameter weigherh 1 lb 2 ounces: If you hold this for a Rule, you may work and correct all Tables of this kind that are made in England: Likewise, I say, you may find the weight of any Iron Ball thus: Say,

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It hath been ever observed for good, that the Tables of Mr. Norson, Smith and Nye; and therefore Capt. Sturmy in his Magazine for Mariners, doth follow the same Rule, and gives us the same Tables of Mr. Nye, as he supposeth refined: for he says, Two Inches and a quarter of a Ball, weigheth 1 fb 5 ounces: I will let you see the Error.

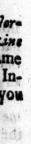
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Now here a Ball of 4 Inches Diameter by his Tables, weighs but 7 fb 6 ounces: But I praise Mr. Norton, who says, We must not expect Truth from his Tables. But Capt. Sturmy affirms his Translation of Nye to be truly Calculated: If they be true, I must be quite wrong.

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Mr.

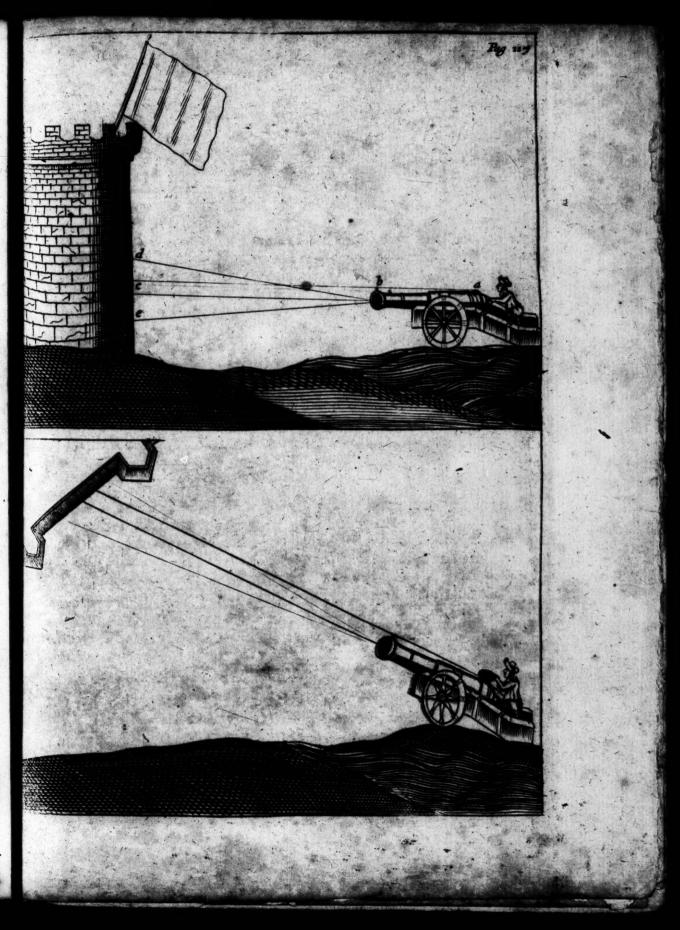
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Now you may perceive, that they err only by neglecting to calculate their Tables. But as the blind lead the blind, so they both fall into the Ditch; for he gives 8 \(\frac{1}{2}\) ib, or 8 th 8 ounces.

And by Capt. Sturmy his Tables, I find a Ball of 8 Inches Diameter to be 58 th 14 ounces; and yet he hath fet down in his Tables a Ball of 7 the Inches for 58 th. And by the Tables of Mr. Nye, though he hath placed 71 th; I can find by his working but 68 th for the weight of a Ball of 8 Inches Diameter.

So this will be proved by the Line of Numbers: for if you fay 4. Inches gives of the what shall 2 Inches give? Place one foot of your Compasses in four Inches, and the other in 2 Inches; keeping the Compasses at the same extent, set one foot in 9, and measure downwards 3 of these Extents, which will reach to 1 to 2 ounces; likewise say, If 2 Inches give 1 to 2 ounces, what shall 8 Inches weigh? Extend your Compasses from 2 to 8 Inches; the Compasses at the same extent, place one foot in 1 part, and three of these Extents will strike at 72 to 8. But if the Weight of a Ball should be demanded in Scotland, you shall find a Ball of 1 to is 2 Inches; and one of 4 Inches 8 to; and 8 Inches Diameter (if you observe the Work of the Table) 64 to; you will find the same by using the Line of Numbers; in saying, 2 Inches Diameter gives 1 to, what 4 Inches and by laying one foot of your Compasses in 2, the other in 4 Inches

Diameter, and with the same extent set one foot in 1, and with three of these extents you shall find 8 is weight: Thus you may do in finding the weight of Ball, knowing their Diameter to what Height you will; and find the true Weight either Scots or English, without being beholden to Tables; though you have in pag. 84, exact Tables Calculated Arithmetically from eight parts to eight parts of Inches unto to Inches Scots Weight: And in pag. 86, you have the like number of Inches Calculated for Ball in English Weight: This is the quickest way, and reasonable true, if there be not holes in the Ball, or, as I have seen some, a great Ring about them, which might have taken up the Wind of the Peece.

Quest. 7. Pray you what Cautions or Circumspections would you use in order to your Approaches making, that thereby the Army might have the least hazard, and greatest speed to come to the Places where the Batteries are to be made for the Cannon, thereby to be more certain of a hopeful and good success over the Enemy?

Answ. To Answer this, you must know you may have many hinderances, if there be a resolute Enemy in the Strength; Neverthe-

less observe

1. You must be careful of your Leaguer, that it be well trenched and secure from sear of the Enemy, in all Quarters, by Trenches and Flank-works; then chuse to set your Batteries most conveniently in the opposition of their Strengths, and observe that there be no Hill, nor deep Ditch to hinder the Souldiers, if occasion offer to an Assault.

2. That your Approaches be intrenched to open or flut, and to make such a way to come to the Batteries, and be sure it be well co-

vered and guarded with Men to keep it.

3. That the Platforms be large enough for the Guns to Reverle,

and also to command the Place they shoot at.

4. If there be Earth enough, that you make the Trenches deep and wide enough, and well flanked.

5. That with Advice and Deliberation, you batter all the high Flankers, the while you are making your Approach-Trenches.

6. When you have brought your Trenches to the Counterscarp, then make your Platform and Beds for your Peeces by the Point of the Counterscarp, by which you may hurt their Low-Flankers, and take them away; and so continuing your Battery, that you bring down their Counterscarp, and the body or face of their Work.

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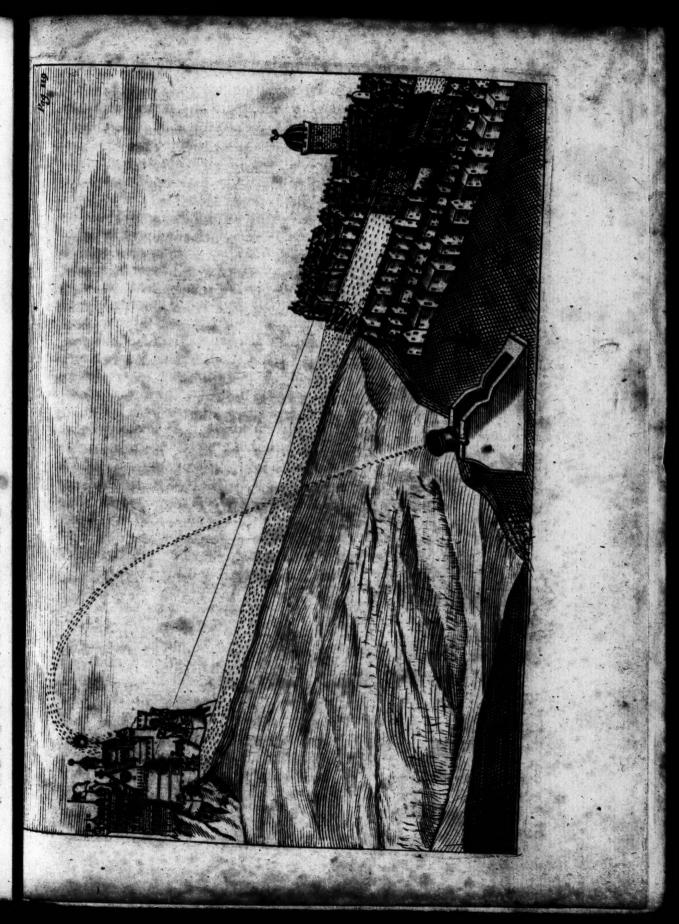
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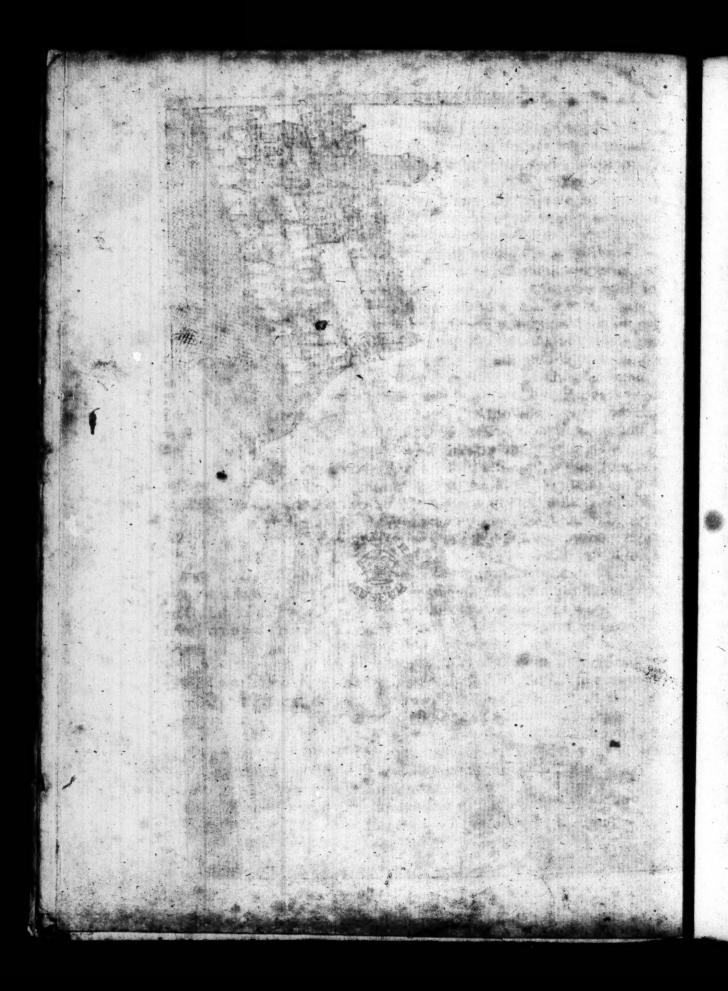
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Quest. 8. When you are approached so near as you can, how shall you then Storm and Breach a Bulwark at the Point, that is both Offensive and Defensive?

Answ. If you use thereto 18 or 20 Peeces, all Whole or Half-Cannon, and plant them so as they may shoot Right Angular, and cross one the other; and if the Approach be so near as ought to be, I would have 4 of my Guns only play to dismount the Enemies Ordnance in their Places, where-ever I could perceive they say, and by this means make my Storm more free.

Quest. 9. If you were to shoot at a distance, what Gun would

you chuse, a Reinforc'd-Gun, or a True-Fortified?

Answ. It is true, that if you elevate a Reinforc'd-Gun to 44 Degrees, and the True-Fortified to the same, shooting both one Ball, that then the Reinforc'd-Peece will drive his Ball more violently, and shall fly farther than the Ball of the True-Fortified-Peece: And great reason for it, the Reinforc'd is long and well Fortified; they of Brais are 10 Diameters of the Bore about the Breech, and his Proof of Powder is 2 parts of his Balls weight, and some the whole Balls weight; and the True-Fortified but 9 Diameters of the Bore, which gives a great difference in Powder, for the is proved with parts of her Balls weight of Powder; besides the one is longer, by half as long again as is the other; for the one being 18, and some 20 foot long, the other is but 10 or 12 foot long: by these Reafons, being better Fortified, hath more Powder, more length, and but equal Ball; the must burn more of the Powder before the Ball be delivered, which must of necessity more violently drive the Ball farther than the True-Fortified Gun.

Quest. 10. Thus it followeth, that the longer a Peece is, the more

firength the hath, and doth violently carry her Ball farther.

As we fay any thing conveyed through a Pipe or Bore, hath his Course more violent according as the Bore is long, and hath been found so to do by some: Bur I say, Experience teacheth otherwise now, for I have seen a Demi-Cannon tryed, being of a reasonable length, and broke a soot and a half at the Muzzle; yet when the Peece was tryed again and again, did carry her Ball as far as she did before.

Quest. 11. How is this, that a Sling doth shoot farther than a True-Fortified Peece, or other such-like Peece, which is shorter

than a Sling?

Answ. Thold that which Reason and Experience both sheweth: Namely, that the strength of any Peece is so much more as the Peece is longer; but being fortified accordingly, and with this restriction, that it is done with an indifferent length; for from 8 to 12 foot long, being of the same Bore and Fortification, the Peece shall add to the slight of her Ball: But from 12 to 20 foot long, you shall see them abate of the Balls slight; The reason is, in all those too long Guns, the Powder is burned before she deliver her Ball, whereby the slame and strength of the Balls slight is abated. This is strange, and opposeth the thoughts of many Gunners; but by my Experience here in England by Saltwick I found it so, and therefore not to be controverted.

Quelt. 12. But if you load a long Peece with fo much more Powder, and being thereto Fortified, should not that give strength to the fire, that thereby the Ball should more vehemently be farther

driven?

Aufw. It is without all question, that a Peece doth most harm has ving its greatest Loading; yet it is found ordinarily, that in all Guns having Powder above half the Balls weight, all taketh not fire; yea, I my self at Saltash in Cornwal, gave a Quarter-Cannon, shooting 12 fb Ball, more than her ordinary allowance, and laying 6 pair of Sheets on the Ground, on the descent of the Ground; and after fire given, I found two ounces of the Powder whole, by which you may guels what more was burnt after it came out of the Peece by the flame; and to I suppose the Balls flight is not increased but diminished: Whereby you may understand that too much Powder is disadvantageous for Ordnance, and that there ought inspection to be had to their Loading: And for these reasons I have Calculated these Tables, which I am sure is the nearest Truth to give Ordnance their Powder, of any yet given out by any other. But I know fome Gunners will be offended to think that by these Tables, the Fortisication of their Guns confidered, they should be drawn to an Account of what Powder they have spent.

Quest. 13. If you were to shoot from the Battery G, in the Figure 112 to the Ship E; if you had your choice, whether would

you use a Demi-Cannon or a Basilisk ?

Anjw. If it were a calm day, and the Sky clear, and the distance betwixt both about 300 or 400 Paces, then I would hold little or no difference which of the two to chuse; but if it were a little Wind, the Sky thick, and the Air damp and moist, I would rather chuse a Demi-

Demi-Cannon than a Sling, or rather a Whole-Cannon than a Demi-Cannon. My Reason is this, That the Wind, and Mist, or Rain, hath not so much strength to divert a great Ball as a small, which is found experimentally: For divers times I have shot from the Castle of Edinburgh to the Links of Leith, when the Enemy was exercising; but when there was a gale of Wind on either side, or against, I found the small Ball to err; but the Demi-Cannon came much nearer my expectation.

Quest. 14. If you were to shoot from a Valley, as at the Point B, against the Hill A, or from the top of the Hill A to the Valley B;

is there any difference in laying of the Ordnance?

Answ. There are divers Opinions about shooting of this nature; for most do say, that shooting against the Hill from a Valley, the Ball will be below the Mark; and likewise shooting from the Hill to the Valley, that the Ball will strike below the Mark; but as I have shewn by my own Experience, these Authors are not to be owned: for I doubt it is with divers that have writ of Gunnery, as that the Proverb will hold good, viz. Many Men speak of Robin Hood, that never shot in his Bow. So I doubt some have writ they know not what themselves, never being experimented.

Ground can be made, by which you can make a Table of Randoms, whereby the Gunner may lay his Peece to shoot such Distance, by

fuch Degrees of the Quadrant being thereto elevated.

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Answ. This I affirm, and my Reasons you have in pag. 103, which if any Man will truly confider, he will either not think to aver Random-Tables, or otherwise to make Tables for every Gun that is made, and also for every Wind and Weather that is, when they are to make use of the Guns; and he must not forget to make Tables for every Ground he is to shoot over: Which will keep them at work all their lives, and never conclude to any good purpose.

Quest. 16. Is it possible to give a general Rule, that instantly you may plant your Ordnance on a March against the Enemy in the

Field, when the General intends to give Battel?

Anjw. I believe not, because of the many hinderances and impediments that do many times follow; for the Rule of Difference is that which must then be observed, and the Order of the General, and therefore is carried a competency of Field-Peeces, which are to be planted at the Head of the Battel, and some between the Vant

and the Middleward, by 2 or 3 together on the Flanks and Wings of the Musqueteers, being covered with the Wings of Horsemen, or as occasion presents and suffers them; some of these on the Front of the Army, playing with diligence on the Enemies Brigades; and if the Fields be plain and even, then as the Army hath by them Cannon, Demi-Cannon, Field-Peeces and Slings, which may be planted for the greater annoyance of the Enemy at a greater distance; for every Regiment ought to have 2 or 3 Field-Peeces, which must be planted at the Head of the Leaguer, and must stand a little elevated with Earth, (if possible); all these will cool the Enemy before the Battels draw near; and some of these Field-Peeces may be removed as occasion will serve, where they may gaul the Luemy so, that Gunners being Men expert, and having good Attendants, may be very advantagious to an Army.

CHAP. XXXIV. The Order and Necessaties for Guns to march by Land, they having six Demi-Cannons, six Sakers or Demi-Culverings, with two Whole-Cannons, besides their Field-Ordnance.

Before the Train doth march, there goeth out Pioneers, each of which is furnished with either a Shovel, Scoop, Pickax, Crow or Handspike; having for their Commanders, a Captain, Lieutenant, and two Corporals, with a Drum to every Company; who are to make plain the way for the Cannon.

After them first follow the 6 Sakers or Demi-Culverings, drawn with their respective Horses, with their Provision of Ball in Waggons, and their Powder in Waggons, besides there must be at the Rear of the Cannon, if any whelm, help sufficient to mount them

again.

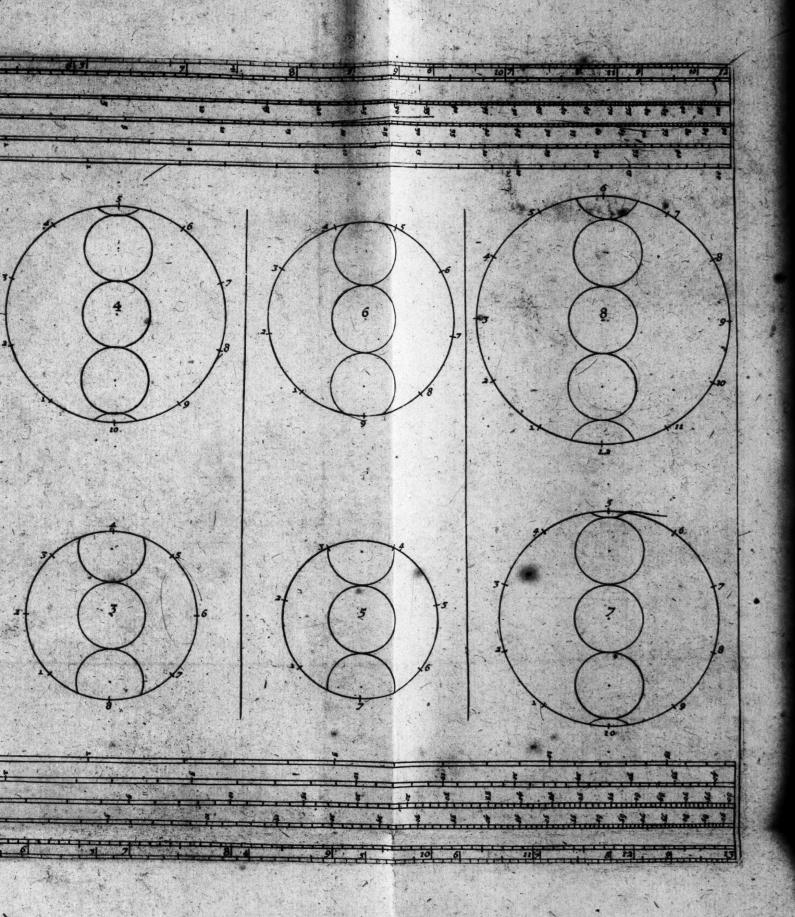
Next fellow them fix Demi-Cannon, with their Shot and Powder conform; Then two Whole Cannon, with their Powder and Ball

accordingly.

Then the Carriage of Ladles, Sponges, and Rammers, Match, Crows, and Handspikes, and Budg-barrels: These besides the Field-Peeces for the respective Regiments, take a great many Horses, Waggons, and Men, for their Attendants.

Now when the Cannons are on their March, every Gunner to his respective place, must march at the right side of his Peece, and by them their Harbingers, who take notice of all the Ropes, and other

arch ations One file Mend Iron Ordinance 8/0 7/0 6/0 5/0 4/0 3/ P49. 122 sp 76. 8/0 9/0 One fide Motal From Ordinance One fide Metal Braft Ordin Neight of the Bore Scots Hopphe Rule



Provisions for Draught, and help them if defective; and allo to see that the Axtrees be well foped or tallow'd, that thereby the Train may march without stop: The Waggon-Master must have spare Horses by his Draught, if any fail either in Waggons, or in Draughts of the Ordnance. Several have given Rules for so many Horses to a Peete of such a Weight; as thus, every 500 fb of Metal for a Horse-Draught; where the Gun is alone, besides the Carriages, must have 120 Horses: So I reckon for Guns, Carriages, and spare Horses, there will be 180 Horses: Now for Powder, Ball, and other Provisions, 100 Horses more with Waggons, besides Waggons for the Officers.

This is supposed to be for so many Cannon in fine plain Way; but the Hories in every Country are not all alike, for I have been drawing Cannon, and allowed but to every Horse 350 fb, and hardly able to perform; but sure it is, where Horses are to be press, there need no halt to be made for Draught, if the Conductors be provident. But if there should forme Cannon to be drawn in places where Horses or Oxen (for if you order a Yoke of Oxen for a Horse-Draught it will be equal) are not to be found; Therefore I will set down a general Rule, how these Guns may be drawn by the strength of Men. And the Calculation shall be made for the forenamed 14 Guns; by which may be reckoned any other Draught

having the Weight.

First, It is conceived an indifferent Man will draw 100 fb, for his part, (but on a plain way); therefore for ordinary, I do allow a Man to draw 80 fb weight: And you will find, counting the weight of these i4 Peeces thus, The Cannon 7000 to a peece, is 14000 to for them two; then the Demi-Cannon 4500 th, and these o are 27000 to; for the 6 Demi-culverings 3200 to apeece, and thele will weigh 19200 to ; which in all is 60200 to : which fum being divided by 80, (the pounds of draught for one Man) will make 752 Men to draw the 14 Peeces of Cannon. Now thele 752 Men to employ with discretion and good order, that every Man may do his endeayour, you are to make fast your Ropes in this manner, on either fide of the Girriage; before on the Hackes one Rope, and on the middle of the Bolt or Brest-band one; And upon every Rope shall be so many Ropes so made fast, as every Man may have 2 toot distance one from another; so that the Draught-Ropes for a Demi-Culvering must be 17 fathom long: Now for the Demi-Cannon and Cannon, they may be reckoned by their proportion; fo the Men are fer to work, as the Figure hereby doth thew,

This

This will be thought a new Invention, but I used the same in my Lord Middleton's Service from Aberdene to Fyvie, where I caused them to make these Sled-seet, as you see fast to the Carriage, in this manner; near to the Breech of the Peece there is a Bolt, whereon the end of the Sled-seet is; and under it, at the foot-end of the Carriage, a Square-hack to lay over the Sled-soot, and then a Rope through the Sled-soot: And a Man or two thereby shall steer a Gun by a Height or Hole, in the way where she is to be drawn, so that many times it saves the Guns from falling over.

And when you are to meet your Enemy, or make use of your Guns, you may lift up your Sled-feet, and lay them all along the fide of the Carriage in manner as you see, on a Hack where they do not trouble, and unhacking the Ropes from the Hacks before,

you may use your Gun at your pleasure.

CHAP. XXXV. By knowing the Weight of one Peece of Ordnance true-boxed, to find the Weight of another true-boxed Peece, being of the Same Metal.

B Ecause it falleth out sometimes, that in a Fort or Ship are Guns, not having their Weight described upon them; Therefore in such Occasions, not to let the Gunner be to seek, but that he may give her Weight without great trouble, I shall here set down some Examples, whereby the Gunner may with ease find the weight of any great Ordnance, whereby he may be able to shew, what store of Horses or Men are competent to draw these Ordnance, if occa-

Thele Examples and Rules I intended to have given by a Gauge-Rule; and because these ways are more easy to do; and quicker dispatched, I shall only take by the way to let you know, that I will admit there is a Brass Saker weighing 1900 it Weight; and as it is given out in other Questions, she is 3 \frac{1}{4} Inches in the Diameter of the Bore: Now it is commonly found, these Guns are about the Breech, measuring at the Touch-hole, 9 Diameters of the Bore: I say then, if I bring 3 \frac{1}{4} Inches all into Quarters, then I have 15 Quarters; with which I multiply the 9 Diameters of her Breech, and I find them 135 Quarters; which dividing by 4, I bring again to whole Inches, and find 33 \frac{1}{4}, which we will here call 34 Inches, for the Circumference of her Breech: Then I say by the Rule of Three; As 22 is to 7, So is 34 to 10 \frac{1}{4} Inches.

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This 10 rt of Inches, is the Diameter of that Saker; if the be true-Bored, the is true-Fortified: And fuch are the only Guns to make choice of for finding by their Weight, the Weight of any other Brass Peece: Therefore, I say,

Example. If a Gun of a 11 Inches Diameter at the Chamber weighs 1900 fb; What shall a Peece of 18 Inches Diameter weigh?

The Logarith	Thus by the	Table of Logar	rithms.	lo affi. 1 and
The Logarithm	n of the gre	ater, 18 Inches	, is ———	-1.255272
Differen	nce increasin	Bu that y that b	ogo or noner of house som	213879
begins the Peer	4.14	Dismeter of the	Come alout do	iace one f
The Tr The Weight o	iple whereo	Peece is 1900	th -	- 641637 -3.278754
Sum is	con an arail	livy busy awal	Laurus comi	-3.920398
Which is the Log		325 lb, for the v	veight of the	great Gun.

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Here you fee that this operateth well by the Table of Logarithms. and the Weight of the Peece is found to be 8325 fb. Now to find the same by the Line of Numbers on the Scale, you are to place one foot of your Compasses in 11, and the other in 18; keeping the Compasses at the same extent, set one foot in 1900, and then triple turning the Compasses, the last foot will touch at 8325, as before.

Another Example.

Also there is a Peece, I know not what her Weight is; but I find the Diameter of this Peece to be 8 1 Inches : And I place the Work to find her Weight as before.

Behold the Work.

The Diameter of	the known Peece i	s 11 Inches	1.041301
The Logarithm of	the Diameter of	the other 8	0.942008

Difference dec	realmo	*crothological as	- 0008-
25 Incremes dec	9	The second second	- 75302
		A TOTAL TOTAL STREET,	3:

ed	off it Triple	e of the Differ	ence is 12 Ei	endon! lo f	208155
to	Which Subtrac	ted from the I	ogarithm of	1900	-3.278754

Which is the Logarithm of 956 1 fb, for the weight of the leffer Peece, which was required.

The weight thus found by Logarithms, you will find the like by the Line of Numbers, if you extend your Compasses from 11, the known Diameter, to 8‡, the Diameter of the Peece whose weight you would have; the same extent three times from 1900 down the.

Scale, will reach to 956 1.

the weight of the great out.

This former Work you may find on the Line of Numbers, if you place one foot in 9, the Diameter of the Bore that begirts the Peece at the Touch-hole, and the other foot in 7, which is most near the Diameter that begirts the other Peece, and the Compasses at the same extent, place one foot in 1900 the weight of the known Peece, and three times turned downward, will light on 256 \frac{1}{3}, as before.

CHAP. XXXVI. By knowing the Weight of one Peece of Iron Ordnance, to find the Weight of another Peece of Iron Ordnance.

Suppose an Iron Saker of 3½ Inches Diameter of the Bore, this Peece weigheth 1600 lb; I find all such Peeces to have 11 Diameters of the Bore about the Breech; for which cause I work as before, and bring 3½ into quarters, which I multiply by 11 the Diameters of the Bore about the Breech, and I find 165, which I divide by 4, to bring again into Inches, and the Quotient is 41: Then I say, by the Rule of Archimedes; As 22 is to 7, so is 41 to 13½ Inches.

Alfo there is a Peece, I know not what here Veight its, but I eee the Diameter of this Peece togs of Inches : And I place the Work to smarker Weight as before.

The Fraction is so small not to be valued.

G.L.

So that I find 13 Inches to be the Diameter of an Iron Saker, whose weight is 1600 th, and that the same is a true-Bored, true-Fortified Peece: Now there is an Iron Peece whose weight I know not, but I find the Diameter of that Peece at the Touch-hole or Charged Cylinder to be 21 Inches: To find the weight of this Peece Logarithmically.

Example. I fay, a Peece of Ordnance of Iron, of 13 Inches Diameter, weighing 1600 it; What shall an Iron Peece of 21 Inches

Diameter weigh?

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The Logarithm of	13	Inches, is	1.173042
The Logarithm of	21	Inches, is	1/322219
			All and an annual day of the

	Difference	increasing	t <del>ediene</del>	word Him	7	2082	76
Diameter.	elcibe to	10) 1:524	1 2 500	i simsa	lliv I	Empely	3

Tripleo	f the Difference	is <del>a continue</del>	624828
The Weight of	the known Peece	1600, is	3 204119

Which is the Logarithm of 6744 th, for the weight of the Peece inquired.

If you will work by the Line of Numbers on the Scale, you will find it near the fame; for if you place one foot of your Compaffes in 13 Inches the Diameter of the known Peece, and the other in 21 Inches the Diameter of the Peece whose weight you desire to know; keeping your Compasses at the same extent, set one foot in 1600, the weight of the known Peece, turning your Compasses three times up the Scale, and you will find the third extent will reach 6744, which is the weight of the Peece required. tion turned three times down the Scale, you have could

Another Example. Hor of Freion Labine

There is also a Peece of Iron Ordnance, whose Diameter I find in the charged Cylinder to be 8 1 Inches; the Question is, to find her weight, and the out to the confidence of the confidence of the

Paying, as Improfe, familied the Conner for whar is recombent

for him to act both by See and Land, with all forts of great Ordsoftes, either true-Bored, Tapard, or Chambershoed a Nouric

As the Eggs here demons rates.

139 In Light to the first o	Tournery.
The Log. of the known Peece 13 Inch. The Log. of the other Peece 8 1 Inch.	hes, is
would I thinky blody area inout in a, to eld a Difference decreating to a same and the same and	0.197489
Triple of the Difference is- Which subtracted from the Log. of	
Which is the Logarithm of 409 fb, for	the weight of the Peece in-
Finding here the weight of this Pee followeth, that great or small Ordnance yet for variety we will have another Example. I will admit there is a Pe is 10 1 Inches; and the weight of this I The Log. of the known Peece 13 Inc. The Log. of the other Peece 10 1 Inches	e their weight may be found; ample. ece found, whose Diameter Peece I demand.
Difference decreating	0.092754
Triple of the Difference is- Which being subtracted from the Lo	0.278262 g. of 1600 3:204119
Which is the Logarithm of 843 fb, for	
This and the former is found on the extend your Compasses from 13, to 8 tion turned three times down the Scale extend from 13 to 10 1, and with the stimes turned down finds 843 fb for the red. And so much for the finding the by to provide what Horses, Oxen, or As the Figure here demonstrates.	e, you have 409 fb. If you ame extent from 1600, three weight of the Peece inqui- weight of Ordnance, there-

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Having, as I suppose, satisfied the Gunner for what is incumbent for him to act both by Sea and Land, with all sorts of great Ordnance, either true-Bored, Taper'd, or Chamber-Bored: Now it, remains

remains that I fatisfy my Friends, who expect to hear fomething of those Peeces that shoot Granado's, or other Fire-works; as like-wife of the Petard; and of their Ingredients, Compositions, and the manner of using them.

## CHAP. XXXVII. Of Powder and its Ingredients.

Coal, being incorporated, should be the only Compositions for Powder: But know this, That who foever defires to learn to shoot in great Ordnance, or to make Fire-Balls, or any kind of Fire-works, should learn to know the nature and sympathy of these three.

Salt-petre that is pure and of a Christal Colour is best; the resining whereof is set down by divers Authors, as Mr. Nye, and others; yet the nature of it is to burn downward, but if pure and well resi-

ned, will burn upward, with a great deal lefs noise.

Brimstone is not and loves the fire, and the fire loves it; it is of a sharp nature; when you kindle it, it fireth upward; its colour is

of a bright Yellow if it be good.

The Coal neither augmenteth nor diminisheth any strength or force of it self, only it soon taketh fire, by which the Salt-petre and Brimstone receiveth the fire, and perfecteth their work. The best Coal is made of the lightest Wood, and the lighter the Wood is, the Coal shall be the better. And it is obvious to all, that when these two opposites, viz. Salt-petre and Brimstone are incorporate, and fired together, the Coal nourishing the fire, there is nothing can resist the force thereof, until the fire dissolve the whole in the Air.

Example. If you load a Gun with Powder, (which is nothing but these Ingredients incorporate) or any other narrow Pipe, so soon as the fire comes to the Body, and the Composition is separate by the fire; then doth it force it self out to the Air so vehemently that no-

thing can withstand it.

Powder is made of divers forts, as Cannon-Powder, Pistol-Powder,

Musquet-Powder, and Powder for Fire-works.

Powder may be tryed three manner of ways; First, put your hand in a quantity of Powder, and gripe it hard, if it crack and make a noise in your hand, you may judge it is good; but if it crack not in your hand, it is either not well wrought, or it is spoiled.

The second way, is by taking a little Powder, and put it on a

fanoth plain Board, or a piece of flat Stone; put fire to it, if nie go up quickly to Imoak, and leave no marks behind it, you may judge it good; but if it burn flowly, and leave white Corns behind it, then you may suppose it is not well incorporated, and hath too much Salt-petre in it, or that there is too much Dust and Coal therein.

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The third is by the Taste; if it be too sharp in the taste, it is like to come moist; but if it taste a little Niterish and Sweet, and hard-corned, it is good: There are several other ways to try the

goodness of Powder, that for brevity I here omit.

Of Fire-Works.

There are leveral forts of Fire-Works, some for Offensive Service, some for Defensive Service, and some for Recreations and Sport: I intend only to speak of those which are to be used in earnest, not minding to meddle with those for Recreation at this time, in regard they are so learnedly treated by divers Authors.

Of Fire-Werks, and those Ingredients used for Compessions.

As there are sundry and numerous Ingredients that may be used in Fire-Works; so Fire-Works are so to be mixed as they may work several effects, according to the several occasions may be produced in War; therefore it is impossible for any Man to lay down Rules, which only must be observed; but that the Gunner may have a taste of every Dish, that are necessary to be used in bringing Enemies to Ruine, and Rebels to the Obedience of their Lawful Princes, observe these following.

The Loading and Use of the Mortar-Peece.

These Peeces are not to be used as great Ordnance, in shooting at great Distances; but, as it were, to throw a Granado, or Fire-Ball, or Stones, over Walls, or into Garitons, being seated high or low; or from a Garison to cast a Ball into the Enemies Works or Batteries, thereby to frustrate them of their intents, by taking

away those Men most active in the same.

The Mortar-Peece may be elevated to any degree of the Quadrant; but the contrary you may observe in great Ordnance, for they cannot be elevated above 45 degrees; and the nearer you approach to any place to shoot at it, you must deball your Peece under 45 degrees; so that if Tables were to be made for Great Ordnance, they may not exceed 45; and Tables for Mortar-Peeces may be made from 1 to 45 degrees, and from 45 to 90 degrees.

Now he that would Load a Mortar-peece, may elevate her Muzzle to what degree he will for his own conveniency: the Peece made clean, you put the Powder in the Chamber, and upon the Powder a Wad of Rope-Yarn, Hay, or what you can provide; then you put a Turf of Earth cut on purpose, that is large, wider than the vacant Cylinder upon the Wad, which fills the Chamber, and then you put the Granado or other Fire-Work above that Turf, and putting Grass or Hay about your Granado, that it may lie as you would in the Mortar, and also to keep the Powder in the Mortar from the fire of the Feusee.

The Mortar-peece being thus loaded, you cannot give fire, with any hope of fuccess, before you observe and know, how far the Distance is betwixt you and the place where you would have your Ball to light, and also know, how far that Mortar-peece can cast her Ball from Degree to Degree; likewise you must observe the Weather, whether it be calm, or blows hard, or if the Wind be with or against you, or if it be to the right or left of you: Having duly considered these things, the Gunner may do well the first shot; but if he err, he must amend the next.

So that it stands to reason, that when you have sound the Distance to the place you would lay your Ball at, that you may know by this Table near what Degree of the Quadrant the Peece must be

laid to reach thither.

90	0	05	403	MARKET STATE OF THE STATE OF TH	661
89	80	74	425	59	673
88	124	73	STREET, STREET	58	693
87	148	172	450	57	708
86	171		473	56	723
85	195	70	496	55	723 737
84	219	69	F 85000 CHRISTON STATE STATE OF	54	751
83	243	68	521	53	765
82	267	67	540		779
STADE STATE OF THE PARTY OF THE	289		562	51	792
80	291	65	580	50	804
79	313	64	599	149	816
78	335	63		48	827
77	359		616		838
76	381	61	644	46	848

Now if you were with a Mortar-peece at the back of a Wall near a beleaguered place, and there were a remarkable place, as Magazine, or Store-House, or Corn-Barn, and it is desired to lay the Granado or Fire-Ball in that place, the distance betwixt you and this place being found to be 243 paces, as in the Figure from A to M; Then look in the Table, and see what Degree is opposite to 243, and you will find 83 Degrees, and to the Mortar-peece A must be elevated to 83 Degrees to cast her Ball or Granado into the House M. Do so with all other.

When you would discharge a Mortar-peece, first you must set fire to the Feusee of the Granado or Fire-work, and you must see it burn well before you give fire at the Touch-hole, and mark narrowly where the fall is, thereby to help the next if need require,

in form as aforefaid.

The Feusees for Granado's or Fire-Balls, may be filled with this Receipt; t part Powder, ½ part Salt-petre, ¼ Brimstone, and ¼ part Rosin, being all well beat to Meal, and moistned with Linseed-Oil.

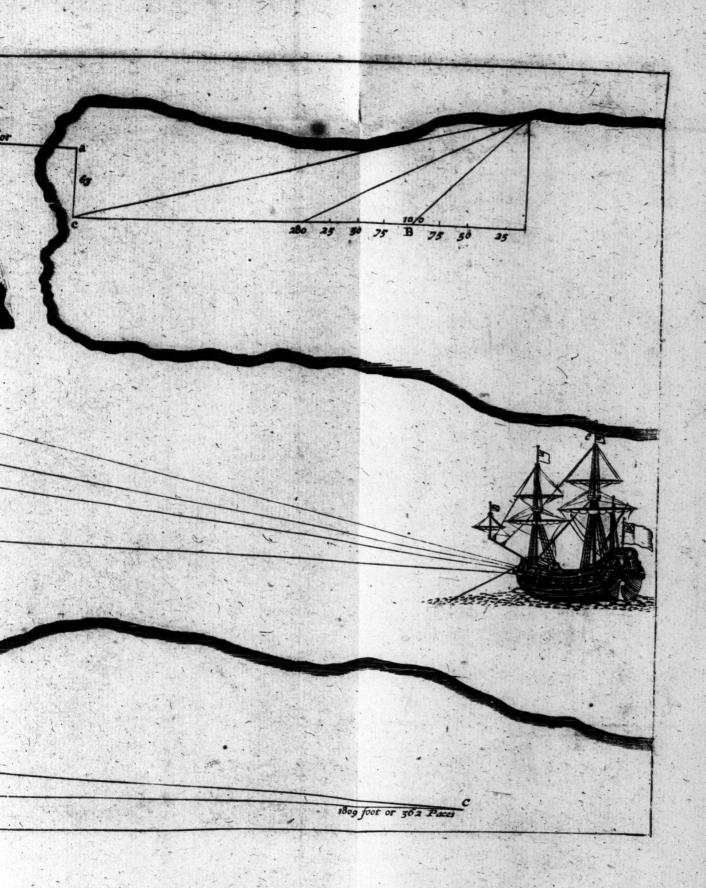
Now follows the Proportion of the Petard, and Use thereof, with all Things belonging thereto.

The best Petards are made of Copper, to wit,  $\frac{1}{10}$  part of Brass: they are made of Iron also, some more some less, as the Figures shew: The Petard A is 12 Inches long, the Diameter at the Breech is  $7\frac{1}{2}$  Inches, and the Diameter of the Concave is 5 Inches; then the one-side Metal must be  $1\frac{1}{4}$  Inches thick; she is at the Muzzle  $\frac{1}{2}$  Inch thick, and the Diameter of the Bore at the Mouth is 10 Inches, and weigheth  $76\frac{1}{2}$  lib.

There is another Petard as B, which is 9 Inches long; the Metal at the Muzzle is 1 Inch thick, and by the Touch-hole 1 Inch thick; the Diameter of the Bore at the Mouth is 7 Inches, the Bore at the

Breech 4 Inches.

To fix your Petard to do good Service at a Gate, or Castle, or other Fort, or Garison; you must have before the Mouth of the Petard a good Oaken Plank of about 2 Foot in square; this Plank may be banded with Iron, both on the one side and on the other, as the 2 Planks D D, both being but one Plank, but the Bands of Iron are on the one side cross the other; the Plank may be 3 or 4 Inches thick; the Powder to the Petard B may be 4 th, and the Powder to the Petard A about 6½ lb; when you have loaded the Petards, and rammed the Powder home, you shall put in the Muzzle of the Pe-



tard a wooden Tamken, which you shall beat home with a wooden Maller, till it be fast enough; then you may fill the Chinks with hard Tallow, and melt Pitch or Wax and run round about the Tamken, that the Powder in the Petard may be preserved from Water. When you are to apply the Petard, and make it fast to a Gate, you must first bore the Touch-hole thereof, and fill the same with some Powder mixed with Linseed Oil: but a Feusee may be better, filled with the Composition for Granado Feusees, that it may take time to burn before the Petard fire, that the Man may remove that made it fast. To make it fast, you must have two Hack-Bolts, as E, with Scrues at the ends, which are to scrue into the Gate, where you have the Plank D, to which the Petard G is fast with a Chain by the Ears in the middle, or by a Staple drove in the Gate, to which the Chain is fast, as you see by the Figure G and D, to the Gate F; To carry this Petard, you must have a Waggon with Wheels, as the Figure H: This Waggon must be as broad as the Plank before the Petard; having in the fore-part three sharp-pointed Iron Pikes, that when it is run at the Gate it may hold fast, that the Man or Men may stand thereon, and fix their Scrues, to which they must make fast the Plank with the Perard: Then giving fire to the Feusee, and removing back the Petard, having done Execution to expectation, the Parties may enter according to the Commands given.

While this Work was intended for the Young Gunners Instruction, I hold it my Duty to shew you that there is no Fire-work that can be invented or made for Offensive Service, but the same will and may be made use of for Defensive Service; but some may be made for Defensive Service, which can hardly be useful in Offensive Service, as Barrels for smoaking out of a Mine, or Balls, or Bags to burn the Wood, or Rubbish cast in to fill up a Ditch,

Powder-pots, and fuch like.

Granadoes to shoot out of a Mortar-Peece.

The Mortar-peece shoots all forts of Fire-works; First, Grana-does, the Shells made of Iron: Secondly, Balls or Bags made of Canvas, in form of Granadoes: Thirdly, a Mortar-peece may shoot Stones coated with Fire-works, or Stones in the Night to fall among the Enemy, as if it rained Stones.

1. For the first the Iron Shell of a Granado must be filled with good Powder, and some well-powdered Brimstone mixt with it,

that thereby the Powder may throughly fire the more suddenly. In your Granado you may put some little Balls of unquenchable Composition, that when the Shell breaks and brings down the Rubbish of a House, those little Balls may raise Fire afterward; which is fearful in a Garison, and is one of the greatest terrors can come among them.

Canvas-Balls for Granadoes.

2. These Balls must be made of strong Canvas; when you have made your Canvas Ball, you may fill it with Sand, and then take two Iron Rings, and mould your Ball strongly in form as you see the Ball in the Copper-Plate N° 3. But if your Ball be of great weight, single Line will not serve to mould your Ball, and therefore you must make it a great deal less than the Bore of your Mortar-Peece, both in regard of the moulding and coating of your Ball.

The Ingredients or Composition to fill this Ball.

Take Powder, Salt-petre, and Brimstone, of each a like quantity, these you shall beat small, and incorporate them together; moisten them with Linseed Oil, and work them with your Hands till you make a Paste, that it may stick together in small Balls is need be: This is a slow Composition.

Another for the fame.

To this Composition you must take 4 parts of Powder, 3 of Salt-petre, and 3 of Brimstone; these being severally beat to Meal, moissned with Linseed Oil, and wrought as aforesaid: This is a good Composition.

Another for the Same.

Take 12 parts of Salt-petre, bray it not very small, and 12 parts of Brimstone not small bear, work them well together, and moisten them with 2 parts of Linseed Oil; then take 6 parts of good Salt-petre, bray it as small as Currants; incorporate these Ingredients, and make a Ball thereof as big as a Walnut; and if it burn as long as you may tell 30 soberly, then is the Composition both good and strong.

When you have found your Composition good, you may fill your

Bag at discretion.

In moulding, you must have 2 Iron Rings of the thickness of 4 of an Inch each of them; the one 4 Inches Diameter, and the other

3; and as you mould the Ball, rive the Line through the Rings; to which you must have a Splice-Iron, or Marlin-Spike of Horn; a tack of Harts-Horn is good to do it with: In the largest of your Rings you may set your Feuse; the Feusee may be made of Wood, the Pipe bored; you may bore 3 or 4 small holes near the lower end; it is the custom of Feusees to reach the middle of the Granado or Ball; you may pierce this Ball when filled with Fire-work, and put therein Iron-Pipes, loaded with Powder and Shot; but be sure the Touch-hole be wide enough, that Rust doth not stop them from siring; these Pipes must be beat in, till their Muzzles be equal to the Line.

Then you must coat this Bag with these Ingredients sollowing; Take Pitch, melt it, and put therein Oil till it be tough and plyable; then put some Powder in it; and if you take Hurds or Tow, and spread on a Table, run this Stuff upon it; then wrap your Ball therein, and open your great Ring for your Feusee-Hole, and stop it with a Plug.

When you are to use this Ball, take out the Plug, and put therein your Feusee filled; then load your Mortar-peece, and set your Ball in the Mortar in the same manner you do your Granado; having laid your Peece as she ought to be, then fire the Feusee, and so your Peece: If this Ball sall near any thing that will take fire, it will burn, and do the Enemy great harm.

For those Stones, that may be shot from a Mortar-peece, if you dip them in Composition made for Water-Balls, with Pitch, Rosin and Wax. When they are coming down (as it were from Heaven) into a Garison, it puts them in great fear, and makes them gather about the Fire.

Then you may have a Mortar-peece loaded, and put therein Stones as big as a Mans Head; and laying her as the other, these Stones falling amongst the People, put them quite out of Heart.

Another Granado for a Mortar-Peece.

If you make a Ball of Canvas, as is before shown, well moulded and filled with Sand, then melt Pitch and Rosin, and dip the Canvas Bag in it; but you may have Musquet-Shot cut in two, and clap them on this Coat as full as the Bag can stand, as you see in the Copper-peece N° 2; then coat it again, put in the Feusee; and if you fire it among Men, it will do great harm, the Sand being put out, and the Bag fill'd with Powder.

Another

Another for the fame.

If you let a Pully-maker or Turner turn of hard Wood two half Balls to join each in other, as the Figure 2 demonstrates; they two being joined make a Spherical Body, as you see, then mould them strongly together with Wire, and with a Goudg cut out little slices of the Wood, as may help lodge half Musquet-Ball; then dip it in melted Pitch and Rosin one dip over, and set shot; then coat it again; this Ball being filled with sine Powder, and a Feusee put into it, it will serve either to be shot as a Granado, or heaved as a Hand-Granado, and will do good Service.

To make a Composition for Fire-Arrows.

Take 2 parts of Salt-petre, 2 of Powder, 1 of Rosin, 1 of Brim-stone; pound these Ingredients very small, and mix them together; then moisten them with Brandy-Wine and Linseed-Oil, or Oleum Benedictum; then sill your Bag of Canvas made for the purpose, very hard and full; then stick an Arrow-head through the Bag, and make it sast with Twine, Rope-Yarn, or such like; and put a Plug for the Feusee-Hole, where you mind to fire it; then coat it over with Pitch, rub Powder in the Touch-hole, give fire to it, and shoot it where you will, and it will burn very well.

But if you would not have it burn, till it light at the place appointed, in regard you would not have it feen, you shall take a little good Tinder of a Fingers length, and put it in at the part you mind it shall take fire; put that Tinder in fire, and shoot it where you

pleafe.

There are Gunners, that when they have moilined their Compofition, clap it about the Arrow, and then lay Canvas about it, and few it fait, bore holes, prime it, fire it, and shoot it where they have a mind; but it must be coated first: The form of an Arrow you have in the Copper-plate N° 5. You may fill the Hedg-hog N° 4, in the Copper-piece with this Composition.

To make Fire-Trunks.

Amongst Fire-works a Trunk is one, for they may be made with easie Charge: First, Cause the Block-maker to make a Trunk of hard Wood, and reasonable thick, (tho' you make the Ball small) you may put two Hoops of Iron about it, and at the great end leave Wood enough to make a Socket for the end of a Pike or Pole.

The Compassions, for Trunks.

Take Brimstone, Pitch, and Wax, alike quantity, melt them over a flow Fire, and put thereto 2 parts of Salt-petre mealed, with a part of Verdigrease, and a part of Camphire; all these being mixed togethen, add a part of Linseed-Oil, stir it well about, and take Hurds, Tow, or Hemp, and make wet with this Composition, which you shall roll up in form of Balls; these Balls you tie together with Twine, and when they are cold, you bore them cross through, which Holes you prime with Powder-dust; you may make of these Balls as many as you please; you may coar these Balls with melted Pitch, and roll them in Powder-dust.

To load the Trunk.

First, Load her with a quantity of Powder, as the Gunner thinks set to carry out his Ball and not break the Trunk; then put home to the Powder one of those cross-bored Balls, and for his Wad to keep him to the Powder, take a little Meal-Powder moistned with Linfeed-Oil and make into Dow; and upon that load Powder and Ball again; then put upon the Ball of this slow Composition; then load Powder, and then Ball, and then of slow Composition again, till your Trunk be full: Then take the Lance and make fast in the Trunk, and set him to your Shoulder in form of a Musquet; let one fire at the Mouth of the Trunk, and you may shoot these Balls round about where you please, and they will burn. These Balls may be used in Iron-Shell Granadoes, or in Wooden-Shell Granadoes, if they be so big as to contain them; for when the Granado breaks they will burn furiously.

To make Balls to show light in the Night.

Take Antimony 1 th, Rosin 1 th, Brimstone 3 th, Salt-petre 1 th, Coal 1 th; make many Balls thereof, bind them up with Tow: If the Enemy lie near your Walls, Ditches, or Trenches, for your own satisfaction, you may fire one or more of these Balls, and throw them over, where you have any suspicion: These Balls will give you light to see, if any be near your Fortification. And if you find the Enemy, you may fire your great Guns of what fort you will for their annoyance, still throwing of these Balls to give Light to know the Enemies proceedings.

To make an extraordinary Fire-Work, which being put into a Mine, or on a Breach for Storm, shall suffocate or kill those who come in

the Smoke of it.

Take of Horse-Litter, that hath been sufficiently spoiled by the Horses, dry it in the Sun; likewise take some of the Dirt that Hogs have lain upon, and dry it also; dried Cow-Gall, old woollen Clouts, chop all these small; then take I part of Wax, I part of Hogs-Lard, 3 parts of Powder meal'd, 4 part of Ratsbane, 4 part Orpiment brayed to Meal, 4 part Verdigrease; mix all these things together, and fill a Bag therewith being well coated, put a Feusee into it, and give fire; heave it among the Enemy, or shoot it to them, it will do excellent Service.

But if you fill a Barrel of this Composition, and set it in a Breach where the Enemy is to storm; if the Wind carry the Smoke from you, the more it burns, the more it will smoke; and I am sure no Man can be able to act in that Smoke; so that you may have great Advantage of your Enemy in contriving this Smoke; as Figure 8 in

the Copper-peece sheweth.

To make a Fire-Work that shall stink fearfully.

Take Brimstone 2 th, Rosin 1 th, Kitchin-Stuff 1 th, Assa Fætida 1 th; melt these together, then take shavings of Horn, or the parings of Horse-Hoofs that are dry, mix a good quantity with the former halted Stuff; then take Hemp, Tow, or Rags of Linnen, or Woollen, or Okam, as much as will drink up the Composition, and make thereof a Fire-Ball; this being roll'd in a little Powder meal'd, and Mans Dung; set fire to it, and it will stink so, as who comes in the Smoke will rather sly, than abide the Smoke, (if they be able); you may put this in Bags, and make Balls or Hedg-Hogs thereof at your pleasure.

To make by Fire, in time of Storm, a Smoke among the Stormers.

Take a large strong Barrel and pitch it close, half full of Quick-Lime; then set in the middle of the Barrel such a quantity of Powder in a close Cask, that, when sire is given, may blow the great Barrel, and all that is in it to pieces; and be sure you put in this little Barrel a Pipe or Feusee filled with Composition, that may reach through the great Barrel; Then fill the great Barrel sull with the aforesaid Lime, and lay it at the Breach, where the Enemy is to storm; and when you see your best advantage, having a Train laid of purpose, you may give fire, and if fire come to the Powder, it will so spoil those about it, that they, by filling their Eyes, Throats, and Noses, shall not be able to see, or walk: By this means the Besieged may have advantage against the Enemy. If Lime were used for cleaning the Decks, instead of Stones, I believe it would give much satisfaction at some times; but Quick-Lime is dangerous, if Water come to it unawares. This Lime is nothing but Lime-Stone burn'd, that no Water hath been near; then it must be very well bray'd, and made as fine (if possible) as Flower; the siner you make it, the greater harm it shall do to the Enemy; and being dry and light, will continue the longer ere the Smoke dissolve.

Another Barrel in time of a Storm.

But if you would play with your Enemy, you may fill your great Barrel with fine pibble Stones, Musquet-Shot, and pieces of old Iron, in form of our Powder-Chests at Sea; this being fired, while they are thick about it, will make rare sport for the Defendant, and make them asraid of worse to follow; and then if you can ply them with Hail-shot from your Guns, and Small-shot, Hand-Granadoes may give them cause to retire, if they can, with the greater safety, as the Figure in the Copper-piece 10, doth shew.

The Propertion of Compositions for Offensive Fire-Works.

t. Take one part of good Powder, one part of Salt-petre, and half a part of Brimstone, and a quantity of Saw-Dust, or old rotten Wood, which will make a great Smoke: These being well mixed with Linseed-Oil, and wrought under your Hands, until you make the Composition to a Paste, that it may hold together to make Balls.

2. Take gross Cannon-Powder 1 th, Salt-petre 1 th, Brimstone 4 of a st; pound these very well in a Mortar, or a Powder-Mill, and mix them together; moisten them with Linseed-Oil, and work them well with your hands to a strong Dow or Paste, as is before-said.

3. If you take very good Powder, beat it very small, searce it through a Sieve, and moisten it with Linseed-Oil, work it to a Dow or Paste; it is good if you make use of it presently; for this Composition is too strong to be kept, and therefore you may add to it half so much Salt-petre, and a little Brimstone, then it may be kept.

4. If you take of the best Pistol-Powder you can get, beat it very small, searce it through a narrow Sieve, moisten it with Linseed-Oil,

work it well, as is before taught, and you have the best and strongest Composition without doubt amongst all the others; but it is likewise too strong to be kept long, and fearful, if dry, to be fired,

5. If you take groß Gun-Powder, as much as you please, and as much Salt-petre, being moistned with Linseed-Oil, and wrought as

the rest, with a little Brimstone.

6. If you take 2 15 and a half of gross Gun-powder, and 4 15 of Salt-petre, and 1 15 of Brimstone, all well beat, and searced through a Sieve; then being moistned with Linseed-Oil, and wrought as before.

7. Take 1 th and a quarter of Powder, 1 th of Salt-petre, 3 quarters of a th of Brimstone, half a th of Spunk, the Heart of Willow, or old rotten Wood rubbed small; all these being moistned with Linseed-Oil, work them well with your Hands as the other Compositions are.

8. To 4 to of Powder, take half a fb of Brimstone, and half as: much Salt-petre as both the other; all these being well pounded and searced through a Sieve, (as aforesaid) and being moistned with

Linfeed-Oil, work as the reft.

9. If to 2 to of Powder you take 1 to of Salt-petre, half a to of Brimstone, and half a to of Coal or rotten Wood, these all being well moistned with Linseed-Oil, and wrought, this will make a good ordinary Composition.

quarter part of these two of Brimstone; these being all pounded and searced, and moistned with Linseed-Oil, and wrought as for-

merly instructed.

of Brimstone, and 6 ounces of Salt-petre; these being all moissned with Linseed-Oil, and well wrought; then you take one fourth part of Spunk, or Saw-dust well rubbed, mix this Composition.

with it, and you have your defire.

pound of Brimtone; these being moistned with Linseed-Oil, and well wrought: Lastly, Take half a pound of Rosin, and as much Pitch small pounded, and searced through a small Sieve, and then a little Saw-dust mixed therewith, with rotten Wood rubbed small in your Hands; this is for the slame or smoke: If you would have it to spread abroad, put some brayed Glass therein. This Composition may be used amongst your Recreations, but it is not to be long kept.

13. Take of Musquet-Powder 12 Ounces, Coal 4 Ounces, Brimftone 3 Ounces, moitined with a little Linseed-Oil; this being well wrought may be likewise used.

These following Compositions should not be moistned at all, but made altogether dry, and so used.

of that of Brimstone, with a little Powder, and a little Coal; all these being finely pounded, and searced through a small Sieve; mix therewith some rotten Wood to increase the same.

2. If you take I pound of Salt-petre, half a pound of Brimstone, a little Coal, and a little rotten Wood, the best you can have, to make a Smoke; the first two pounded and searced, and the rest mixed therewith.

3. Take 2 ounces of Powder, 1 pound of Salt-petre, 2 ounces of Mercury; rhefe 3 well pounded and fearced; then 2 ounces of rote ten Wood rubbed between your hands, and 2 ounces of Pitch; thefe

two beaten small not searced, mix them to the other ingredients.

4. You may take I pound of Salt-petre, pounded and searced, a little Spunk, with a little Rosin; work the same as aforesaid, then mix them all together.

5. If you take Salt-petre and Brimstone, each alike, and a little rotten Wood; this is also a good Composition in Balls or Bags, and will keep long unspoiled, and hath likewise no danger in the siring: It is esteemed to be the best of all Compositions, and gives no strong sire, as the moistned Balls do.

them with Coal, or rotten Wood which is light; if you use to these Balls Feusees it will not be amis, or some of the slow Composition moistned with Oil.

All these may be made in Cloth-Balls, coated as aforesaid, and made use of as the Gunner pleaseth, for offending of an Enemy.

As there is nothing now unlawful, (though never so base) that can be acted against an Enemy; so it is very common for Persons to take upon them to be Spies and Intelligencers, who void of sear will enter with the Enemy in their Army, Leaguer or Garison, on purpose to betray them. Those Men who will give themselves to be Spies, they must certainly be of an idle and base disposition, void of the sear of God or Man, and subtil, secret, and Masters of all Villany; yet there are many simple Men, that for love of Money

do put themselves out for this use; these Men, although they be inflired in what they are to go about, and how they may carry themselves in the same; nevertheless, either before or after they have done their Business, by some instinct of Fear, otherwise by the Justice of Heaven, they are cast down, and by their own Simplicity divulge something, which brings them to be apprehended, and through Torture confess the Matter, and according to the Law of Arms receive Justice beyond other Malesactors, in regard the Offence of Treachery, under the colour of Friendship, is a Treason, and Treason is as the Sin of Witchcraft, which will certainly be punished both by God and Man.

But if the Gunner should have occasion to use one of these for his secret Business, he should chuse one of those, who had been employed in such business before, and of such a nature, that though he be threatned, and asked Questions seeming as though he might have been betrayed; nevertheless he must stand unalterably to his own imocency, without Fear to change his Colour, or coldness of Heart to tremble; but with a merry Countenance, dexterity in

Speech, knowing fubtilly to answer what is demanded.

l do remember, at the Line at Leith, when His Majesties Army lay there; one Day there came a pretty subtil young Man from Cromwel's Army, making his pretence that he had left his Service of purpose to serve the King; he was brought before General Alexander Lestie, who put the Matter slightly by, and gave the young Man leave and freedom to take Service where he pleased; whereupon he took occasion to go down the Line, see all our Army, and continued two Days: I sent for the young Man, and in company I did alledge he was a Spy; he put it off with the finest lokes that could be; assuring me, There was not a faithfuller Subject than he in the Army, swearing effectually to the point; but that Asternoon he went to the Enemy to receive his Reward. He was a sprightly young Man, but of a solid and discreet Behaviour, that indeed I did admire his Audacity and Impudence. This Fellow was fit for a Spy.

Another; when I was in the Castle of Edinburgh, a Souldier came running right up from the Enemies Works, that if he had been a Run-away, they might have killed him; but this Fellow came running into our Moat, and when he was there, seigned him-felf mad, and would be up; the Governour Dondass desired to have him up; so I caused hale him up by a Rope about his middle, (I am

fure.

fure the Wall rubbed the Skin off his Hand); yet when he came in, he was flabbering, as it is faid David did before the King of Gath, I Sam. 21. but hear what he would, and fee what he would, he answered nothing to that purpose; but after he had been that Day and Night in the House with the Governour, he sound the way back to the Enemy without help. Such as these are worthy to be Spies.

Now though I will not encourage any Person to any Action so far below a good ingenious Spirit; nevertheless I will shew you what Fire-Balls they use, and the subtilty they use in the perusing those Fire-Works in laying of them: And therefore for Examples sake, I will here shew the use of them, that thereby you may the better

guard your selves from the treachery of Spies.

They use these following Fire-Works, when they intend to burn the Barns of Corn, or Store-houses where the Corn of the place lyeth, or Powder-Magazines, in regard it is impossible for them to come into them, but that it is useful and necessary they have some Windows or Slits in the Walls, wherein they heave their Fire-Work,

which is made in this manner.

Take one part of Colophony, or Rolin, two parts of quick Brimflone, one part of Salt-petre, these three pounded very small and mixed together, put to them so much Linseed-Oil as will make the Composition like a Conserve, then make Balls of the same, and if you will, you may make it for Arrows to shoot out of a Bow, or Crossbow, or by observing what is said of Fire-Trunks, they may be sed in the same manner, or they may be heaved by a Manshand.

There are other Fire-Works that they use, as this strong Com-

polition.

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Take 3 parts of Powder, one part of Brimstone, which being pounded small to Meal, mix them very well in a Bowl, put into them the bigness of a Walnut of Greek Pitch, or Colophony, which must also be small stamped, and in the mixing you shall let some drops of Turpentine fall, as also a spoonful of Linseed-Oil, and then make it to Paste with Brandy-Wine, that if occasion be you may make Balls of it.

But if you fill Bags with this Stuff, well pack'd together, and make therein a Hole, and put a stopper into it; then dip these Bags.

in the following Composition.

Take one part of Brimstone, let it melt, and put into it one quarter part of Wax; when that is melted, put in one part of Pitch.

dance.

Pitch, and let that melt, and ftir them together, take it from the

fire, and mix into it one quarter part of Powder.

Or Coat these Balls with this Composition; Take 3 parts of Brimstone, melt it, and put into it one part of Wax, and one and a half of Grease, one quarter part of Turpentine, and as much Vernice; when all is melted, set the Kettle a distance from the Fire, and put therein 3 parts of sine Powder; mix them, or stir them well cogether: When this is to be used, you shall take the stopper out of the Prime-hole, and in the place thereof, put in a piece of Match as long or short as you please, according as you would have them to do execution. The making of this Match you are taught in pag. 146. To such Actions as these the Match must be chosen that smoaks not, for they use to sye till a certain time, and smoaking Match will discover them.

Example. I defire a Fire to begin within 3 hours time, therefore I take a long piece of Match, which I intend to use; and I measure the same exactly; I light that Match, and mark how much of it burns; of an hour; I measure my Match again, by which I know how much is burned in the quarters time, and 12 times so much must be the measure of Match for the time appointed; it must be laid Serpent-like about the Ball, that the parts touch not one another, neither the Bag, as the Figure in the Copper-Piece, No. 7.

There are some may make ale of the Fire-Arrow, which may be

made fundry ways; fome make them thus:

Take Powder 1 part, 2 parts Brimstone, and 1 part Salt-petre, each well pounded to Meal, and searced; mix these three Materials together, moisten them either with Brandy or Linseed-Oil, and then melt Rosin, and pour it into Water, which makes it hard; then pulverize it, and take one part of it and mix with the former Ingredients; then pound them together very well till they are fit to make Balls of; then may you take of this Composition, and lay about an Arrow-Head, and wrap it about with Fustian or Canvas, and seize it about the shank of the Arrow-Head; this Arrow-Head so armed, you coat it as other Fire-Works; then make a Priminghole towards the point of the Arrow; stop it, and when you make use of it, sire and shoot it where you defire: As the Figure in the Copper-Piece, N° 5.

## Here follows Compositions for Five-Works for Storm, divers

1. Take Powder 4 lb, Salt-petre 3 lb, Brimstone 1 1 lb, Rosin 1 lb; these being all well bear and mixed together, and moistned with Linsced-Oil. This is a good Composition for Fire-Balls, and burns in the Water.

## To make Fire-Balls to burn on the Water.

2. Take Powder 15th, Salt-petre 10 th, Brimstone 4th, Rosin: 2 th; moistned with Linfeed-Oil.

3. Take Powder 10 fb, Salt-petre 8 fb, Brimstone z fb, Rolin

1 16 moilined with Linfeed-Oil.

4. Take Powder 4 th, Salt-petre 6 th, Brimftone 2 fb, Rofin 1 th;

moistned with Linseed-Oil.

5. Take Salt-petre 8 tb, Brimftone 8 tb, Coal 1 th, Antimony 1 th, Amber 1 fb, Camphire 2 fb, Turpentine 1 fb, Rofin 1 th; all beat fmall and moifined with Linfeed-Oil.

## Another for Water-Balls.

6. Take Powder 9 th, Salt-petre 7 th, Brimstone 2 th, dry Tan-

7. Take Powder 3 fb, Salt-petre 2 fb, Brimftone 1 fb, Colo-

phony 1 th, Amber 1 th; moistned with Linfeed-Oil.

8. Take Powder 6 15, Salt-petre 6 15, Brimstone 4 15, Colophony 3 to; all small beaten, and moistned with Linseed-Oil.

9. Take Powder 1 th, Salt-petre 1 th, Brimstone 2 th, moifined."

with Linfeed-Oil.

10. Take Powder 2 fb, Salt-petre 1 fb, Brimstone 2 fb; moultned with Linfeed-Oil.

11. Take Powder 2 fb, Salt-petre 2 fb, Brimstone 2 fb; all bear small, and moistned with Linseed-Oil: These Balls may be used to Fire-Works and Fire-Balls.

12. Take Powder 2 th, Salt-petre 5 th, Rotten Wood, or Tanners Lee 1 th, good Brimstone 1 th, Salt 1 th; these all beat small, and mixed together, moistned with Linseed-Oil.

To make a long burning Composition for Fire-Balls.

of Steel 4th, Saw-dust 4th; and after you have moistned the Composition, mix the Filings of Steel and Saw-dust amongst it;

then make Balls of this Composition, and tye them as other Balls.

Another that is fofter.

14. Take Salt-petre 5 th, Brimstone 2 th, Coals 1 th, Saw-dust

1 fb. mixed amongst it.

13. Take Salt-petre 2 to, Brimstone 1 to, Powder 1 to; these being beat small and mixed together, take Turpentine, melt it, and moisten these ingredients in it.

Another Composition for Fire-Arrows.

16. Take Salt 8 th, Brimstone 3 th, Coals 1 th, Saw-dust 1 th.
17. Take Salt-petre 2 th, Powder 2 th, Brimstone 1 th; you may use it to what you please.

For Powder-Pots, or Stink-Pots.

Take fine Powder, mixt with some Brimstone small beat; put therein some Assa Fatida, some pieces of Verdigrease, and some Camphire: This heaved in a Ship's Round-House, Fore-Castle, or betwirt Decks, will make a fearful Stink and Smoak.

To make Match that [ball not [monk.

Take a glazed Earthen Pot, and put therein clean red Sand till it be if full; coil therein March, so that no part thereof touch other; then cover it well with the foresaid Sand, and coil March thereon as before, and then put Sand above it till the Pot be full; which done, you are to put the Cover on the Pot, and lute it close, that no Smoak come forth of it; put this Pot into a Sinder or Charcoal Fire, and cover it all over; let the Pot stand there till the Fire extinguish of it self; then take it out, shake the Sand off, and your Match is ready.

I could infinitely have added, but being straitned, do conclude, That as yet to the Art of Gunnery there is

NO END



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Composition and the

